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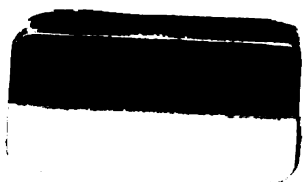
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# **PEAKS AND GLACIERS OF NUN KUN**







*On a projecting rock buttress of Pinnacle Peak, at altitude of 23,000 feet.*





# PEAKS AND GLACIERS OF NUN KUN

A RECORD OF PIONEER-EXPLORATION AND  
MOUNTAINEERING IN THE PUNJAB HIMALAYA

BY

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'ALGERIAN MEMORIES'

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*All illustrations were made in Germany from photographs  
taken by the Authors.*

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The accompanying map of the Nun Kun Massif and surrounding region was made by Dr. W. Hunter Workman from actual observation, with angles taken by prismatic compass, and photographs, and adapted to the Indian Atlas, sheet No. 45 (S. W.). Heights from Boiling-Point observations compared with simultaneous readings at lower Government Station at Dras.





## CHAPTER I

**Necessary Preparations for the Nun Kun Expedition—Guide and Porters—  
From Srinagar to Suru—Description of the Nun Kun.**

**APRIL** of 1906 found the authors again in Srinagar for the fifth time. We did not propose to go so far afield this season as previously, our object being to carry out a plan, long cherished, of exploring the Nun Kun group of mountains, about a hundred miles east of Srinagar, in the Province of Suru south-west of Ladakh and north-west of Zaskar. Late in the summer of 1898, in descending the Rangdum valley on our return from Northern Ladakh and the frontier of Chinese Turkestan, we saw for the first time these mountains towering above its western end. Several dazzling white snow and rock-peaks lifted their heads high above the neighbouring mountains, surrounded by a multitude of sheer rock-aiguilles with tops dashed with snow, which, tinged by the red afterglow at evening, shot up into the cold grey sky like prongs of flame.

## 2 PEAKS AND GLACIERS OF NUN KUN

The rugged, savage beauty of the group and the evident complexity of its formation proclaimed it a most alluring field for investigation, which we would have liked to make then and there, but lack of time and of proper outfit compelled us to pass on and wait for a more convenient opportunity, when, should circumstances permit, we determined to return and explore its untrodden mazes.

The European contingent on the proposed expedition was to be more numerous than on previous ones, as we had decided to try a new experiment, viz. that of employing Italian porters to carry camp-outfit to points above those to which coolies could be taken or would willingly climb. We had had more than enough, in the past, of sitting on cold snow-slopes awaiting the snail-like approach of unwilling coolies, and at snow-camps of hearing their wailing complaints and refusals to march.

Cyprien Savoye, guide of Courmayeur, who had been with us in Baltistan in 1903, was engaged for the expedition some months previously, and he, with the advice of our friend, Signore Ettore Canzio of the Turin Alpine Club, to whom we are greatly indebted for assistance on this as well as other

expeditions in arranging with and forwarding guides and porters to us in India, chose six porters, also of Courmayeur, to serve under his direction. Several of these had nearly completed their course as porters, and were, so far as knowledge of mountain-craft is concerned, guides in all but name. The guide and porters left Marseilles on 9th May, and we meantime were busily occupied in completing arrangements at Srinagar.

In attempting an expedition to Suru this season there were two discouraging factors: (1) owing to failure of crops in Suru the two preceding summers no supplies were to be had there, and all the rice, corn, and meal required to feed our coolies during the season, as well as our own baggage and supplies, had to be forwarded twelve marches from Srinagar, thus necessitating large advance-caravans; (2) the easiest and quickest route to Suru, of which the first nine marches were over the Leh route, was much congested by unusual Government transport during the months of May and June, and there was great difficulty in procuring a sufficient number of ponies.

We therefore decided to send our first caravan



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by the Wardwan valley, a coolie-route. To do this a reliable agent to superintend the transport must be secured. The Kashmir pundit, who had done fairly well in a similar capacity during our last expedition to the Chogo Lungma, offered his services, but we considered him unequal to the task this time. An Englishman, an ex-police-officer from Calcutta, who spoke Hindustani fluently and was said to understand the management of natives, was living in Srinagar. He expressed his willingness to undertake the task. His appearance did not indicate that he was the sort of man one would select to lead a large coolie-train over rough roads and a snow-pass, and he was decidedly on the shady side of sixty. But he was energetic, accustomed to plenty of exercise, and, best of all, enthusiastic in his desire to go with us. Furthermore he was a European, and more likely to work in our interest than a native would be, so he was engaged.

The next step in the preparations was mathematical. Calculating how many coolies would be needed to transport fifty loads of supplies and a hundred and fifty maunds (12,000 lbs.) of grain for coolies was simple, but then followed the estimating





of the amount of grain required to feed the coolies who were to carry the above, which amount again had to be carried by other coolies, who in their turn had to be fed, and their food must be carried by a third set, also to be fed. And so on in a diminishing ratio, until the problem assumed proportions that fairly staggered one's power of calculation. A wise man of Srinagar said to us, 'You cannot handle that route, the coolies will eat their heads off.' Indeed they did, and, when not content with that process, they pilfered liberally. However, the route and the numerous obstacles besprinkling it were eventually handled. Early in May Mr A. Hogg left Srinagar with two dungas loaded with camp-baggage and grain for Islamabad. A few days later he left the latter place with two hundred and forty-three coolies for the Wardwan valley, one of the largest private explorer's caravans ever made up.

Two weeks later a second caravan of twenty-five ponies carrying grain was despatched under charge of one of our Gurkhas by the Leh route, and we now had a, seemingly, free bill to prepare our personal caravan. The preparation for this was nearly completed, when a despatch from the ex-police-

## 6 PEAKS AND GLACIERS OF NUN KUN

officer fell on us like a thunderbolt from a clear sky. On the sixth march out one hundred and fifty coolies had bolted in the night carrying off fifteen to twenty maunds of grain. We surmised that the propinquity of the 14,000 foot glacial Bhot Kol pass might have had a good deal to do with their departure, as the Islamabad coolies are notorious cowards when required to venture on snow, and our surmise proved to be correct. The Resident was consulted as to what could be done, and asked whether the native authorities would not compel the coolies to return and fulfil their contract, which they had voluntarily entered into at wages one-half greater than those usually paid, or furnish others in their place.

He laid the matter before the Durbar. After some days that august body replied, that they could not force coolies if they were unwilling to march, but we were at liberty to enter a suit against them for the theft of grain. We had more important work on hand just then than collecting evidence and conducting a criminal suit against a lot of irresponsible coolies, whom we had never seen and whose names were unknown to us, before a





tribunal whose powers were of an undefined and shadowy character, or in trying to compel them by legal means to fulfil their contract in a land devoid of a contract-law. A person, who would be turned aside from his main object by such a trifling matter as prosecuting delinquent coolies, would not accomplish much in the way of exploration. His only chance of success is to push steadily ahead regardless of imposition and losses. We recognised that, under the conditions existing in Kashmir, we were helpless to render our agent any assistance in this crisis. While we were considering what should be done, a letter arrived from him stating he was doing what we hoped he would have the sense to do—moving towards Suru by half-marches with the remaining hundred men.

On 8th June Savoye and the porters arrived in two tongas at the hotel. Greetings exchanged, we took them to their tents pitched in the compound, and told them they would find meat, vegetables, and other accessories at hand, so that, as soon as settled, they could proceed to cook their dinner. Another experiment with the guide and porters was to be tried this season. They were to do their own



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cooking. In former expeditions there had been frequent complaints, that the Kashmiri khansamah not only prepared their food in an improper and unappetising manner, but restricted the quantity to inadequate amounts, although he was supplied with more than sufficient for their needs. When a sheep was killed for their use, he would, perhaps, give them a fiftieth part, reserving the larger and best portion to swell the bill of fare of himself and the bearer. There was no question as to the justice of these complaints, which comport perfectly with the character of a Kashmiri khansamah and were fully proved in the case of ours, but we were never able wholly to regulate his conduct, and this time we resolved he should have no opportunity to offend.

At our request Savoye had selected among the porters one who could cook, indeed so well that he was the proud possessor of several medals from Italian cooking-societies. Although his real *métier* was mountain-climbing, he was seen an hour after the arrival of the party in Srinagar, with shirt-sleeves rolled above the elbows, preparing fifteen pounds of mutton over a native fire, as if he had done nothing





else in his life. The guide and porters were provided with a tent-servant to make their chapatis, wash their cooking-utensils and dishes, and otherwise assist them, but they prepared the rest of their food over a native hearth and, in the snows, over a primus stove, and were entirely satisfied with the arrangement. It saved us a lot of trouble, for they had everything needed, lived well, and there were no complaints.

We left Srinagar with twenty-five ponies on 10th June, and followed the Leh route as far as Kargil. Besides four Kashmiri servants we had two Gurkhas kindly loaned by Colonel Powell, commander of the 1st Gurkha Rifles. One of these became ill and had to return from Suru, but the other, Colonel Powell's private orderly, remained throughout the expedition, and proved very useful in forwarding supplies, conducting coolie-caravans to and from Base Camp, and distributing rations. One Islamabad shikari was employed to take charge of coolies on the march. While he showed himself the most efficient of any of his kind we have dealt with, he adhered to traditional shikari-methods, collecting dastur, whenever possible, and even going so far on one occasion

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as to sell our grain, in transport under his care, to the natives in open market. We were quite satisfied, at the earliest suitable opportunity, to pay him off and wish him Godspeed.

Srinagar may be regarded as the Kashmir El Kantara to grand regions beyond, but one is heartily glad, after weeks of wearisome preparation, to shake its dust from one's feet. The march up the Sind valley was uneventful. Bad weather, as on four previous occasions, was our lot on the redoubtable Zoji La, and we fully endorse the opinion of Dr Sven Hedin, that in early summer or late autumn it is, considering its low altitude, one of the most disagreeable of Himalayan passes. It was pouring and hailing when the advance-guard, consisting of the Memsahib and two porters, made a rush for the three-quarters station bungalow at Mitsahoi, east of the Zoji La. A sportsman, ensconced in one of its two barren rooms, hastened to open the door of the other room for the dripping guests and to offer that panacea, a cup of tea. He appeared a bit mystified when, ten minutes later, six more Europeans came up in streaming mackintoshes followed by twenty-five soaked baggage-ponies. Although told he must not





think of supplying tea for the whole party, he insisted on doing so, and before the wet descent to Matayan was continued, one and all had been warmed and solaced by a cheering cup. This was the last rain we saw. Only one or two snow-squalls occurred in the next ten weeks to mar a summer of unusual good weather.

At Kargil we remained two days engaged in tiresome interviews with the Tehsildar, who had agreed to furnish a permanent corps of sixty coolies for further use. Thirty of these, he said, had already gone on to Suru, but it required much talking to settle for twenty-five ponies to transport us thither and for twenty-five more coolies. The Naib Tehsildar, his assistant, who supported him morally at these interviews, availed himself liberally of the Egyptian cigarettes we offered him. The Tehsildar, between sputtering about our being 'God's creatures and subjects of King Edward,' and, with Eastern figurative expression, signifying his desire to assist us as far as he could, dislodged a large artificial tooth, which fell on his knee, and, after being slowly replaced, speedily fell out again when he attempted to speak. This time he caught it in his hand and returned it to his



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mouth, with, alas, no better result as regards its permanent position. These manipulations of the tooth naturally interfered with the perspicuity and continuity of the conversation upon transport matters, besides filling our minds with awful misgivings as to the capability of the Kargil dental surgeon, should one of our party require his services during the season.

A man of better appearance than the other coolies was shown us as having been carefully selected by the Tehsildar to accompany them, keep them up to their work, and settle any disputes that might occur among them. He was to carry no load, receive double the pay of the others, and was designated by the Tehsildar as 'mate.' Having agreed to accept him into our service we made a note of his name. At the next meeting with the Tehsildar the mate so carefully chosen by him failed to show up, and another man was exhibited as the prospective mate. The reason given for the change was, that the coolies, not being from the same district as the first mate, had refused to go with him. Though this reason was not satisfactory we accepted it, as, on the chances, one mate would prove of as much or

as little value as the other. This mate, accompanied by twenty-five coolies, left Kargil on the same day we did, and reached Suru at the same time.

Arriving at Suru three days later, we were met by Mr Hogg, who led us to the best camping-ground, a small bagh shaded by willows below the village near the river. He was well settled in one of the village houses on the bluff above, where he could keep guard over the grain and boxes stored in an adjoining apartment. There must have been a second entrance to the latter, for each time he went to Kargil on business he locked the door securely, putting the key in his pocket, but on his return he always found several bags of grain had been abstracted. However much the Suru villagers may have suffered from famine the two preceding years, now they certainly battered at our expense, at which not only the coolies but a not inconsiderable part of the rest lived the greater portion of the summer.

Our first question on meeting Mr Hogg was, 'Have the thirty coolies sent by the Tehsildar arrived?' He replied, 'Not one,' adding further that not a coolie was then available in Suru, all being absent on Government service. He was

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accordingly despatched at once to Kargil to demand an explanation from the Tehsildar of his statement to us, that thirty coolies had gone to Suru, and to bring back with him as many others as possible. Meanwhile, irritating as it was to be obliged to waste several days in fine weather awaiting his return, we had no other alternative.

The Nun Kun mountain-group lies a few miles in direct line south-east of Suru, between  $33^{\circ} 55'$  and  $34^{\circ} 5'$  lat. N., and  $76^{\circ} 2'$  and  $76^{\circ} 13'$  long. E., as shown on the Indian Survey map. The massif is comparatively small and compact, standing up by itself in the midst of a network of mountains and occupying, practically, a square with a side of eleven to twelve miles. Two parallel spurs of the same fold, connected indirectly with the Nun Kun by narrow ridges, run west to  $75^{\circ} 53'$  long. E., enclosing a glacier eight miles long, but these can scarcely be regarded as a part of the Nun Kun massif. The highest central portion is guarded on all sides by a multitude of ragged, precipitous spurs or buttresses, which run down from it to the surrounding valleys. They culminate in pointed or serrated summits attaining heights of 18,000 to 20,000 feet. On the





north and east they fall very abruptly, and their broken, often perpendicular, walls offer insuperable barriers to the approach of the explorer. On the other two sides much broken glaciers and steep ice-walls, while not rendering the main peaks inaccessible, make the approach to them and their conquest matters requiring mountaineering experience and skill, as well as thorough mountaineering outfit, and careful preparation. The northern slopes overhang the Suru river in the Rangdum valley for eight miles, for which distance with the opposite mountains they enclose a gorge, through which it flows.

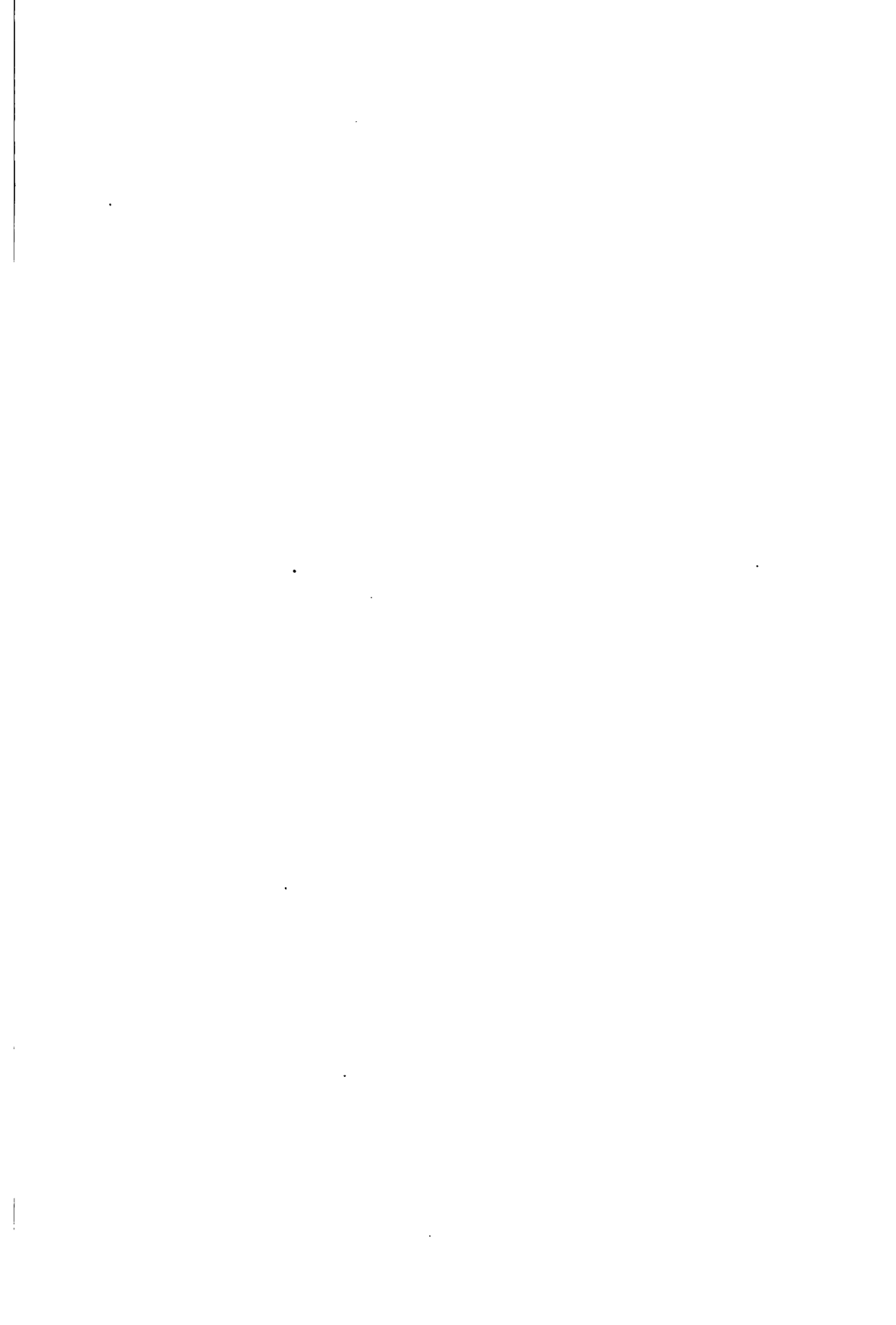
The central part of the massif rises 2000 to 4000 feet not only above its own lesser peaks, but above all others for scores of miles around, the nearest peak that exceeds it in height being Nanga Parbat, 120 miles north-west. East, west, and south, none of the multitude of mountains overlooked by it approach it in height. It stands alone, a lofty island of rock and ice, towering bold and sharp from an ocean of surrounding peaks to an altitude measured at 23,447 feet.

A parallel may be drawn between the Nun Kun

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and Ruwenzori in Africa, lately explored and ascended by H.R.H. the Duke of the Abruzzi. Both tower high above the level of the regions in which they stand, and both are compact, circumscribed massifs culminating in several peaks of nearly equal height. The Nun Kun, however, is larger, occupying a square with a side five miles longer than that occupied by Ruwenzori. Its central peaks are much steeper, more broken and ice covered, and attain altitudes 6000 feet higher than those of that massif, and its glaciers are far larger, more complex, and more perfectly developed.

Although situated in a fairly well-known region, the valleys around it having for years been visited by sportsmen and somewhat by travellers, its height and inaccessibility had rendered its higher parts, up to the time of our expedition, secure from intrusion. In 1899 Major Lucas attempted with Gurkhas to climb some of the rough lower slopes bordering the Ganri glacier, but did not get very far. Shortly afterward Major the Hon. C. G. Bruce made his way over the heights west of the Nun Kun to the Bhot Kol glacier, but made no attempt on the Nun Kun itself. Sportsmen have occasionally entered





## CHAPTER II

Our Feathered Companions—From Suru to the Head of the Rangdum Valley—Coolie-Experiences—The Gempa—The Lama-Lambardar and his Lady-Companions.

MR HOGG, who arrived at Suru two weeks before we did, had orders to buy and have ready for us a sufficient number of sheep and fowls. He had no difficulty in obtaining the sheep, but he was able to procure only one dozen fowls, the supply of these having, probably, been reduced by the two seasons of famine. Of these one was a cock, a rather small bird, entirely white, with low broad comb, piercing yellow eyes, and sharp well-turned spurs, which testified that he had reached the age of maturity and could no longer be called a chicken. He, evidently, had an excellent opinion of himself, strutted about with an air of great importance and decision, and busied himself in marshalling the hens around the courtyard of the lambardar's house, where they were permitted to range at will and pick

## METHOD OF TRANSPORTING FOWLS 19

up such scanty subsistence as its precincts might supply.

These fowls were carried on the march by the coolies, being distributed among them for this purpose. Journeying in this manner is no sinecure for the fowl. Its legs are tied together with a woollen thread, and it is perched on the top of the coolie's pack, to which it is secured by the free end of the thread. Its feet being thus hampered, it cannot retain its position with any degree of certainty. When the coolie shoulders his load, puts it down, or makes any unusual movement in marching, the fowl loses its balance, which it strives to regain by vigorous use of its wings, but often fails to accomplish, falling over the edge of the pack and dangling helplessly head downwards by the thread, until replaced in the upright position. Constant exertion of this character throughout the day without food or water in the hot sun so exhausts it that, when liberated at the end of the march, it lies panting on the ground with open beak unable to move about.

Between marches it is left uncared for, to find its food as best it can. The idea of feeding fowls to

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keep them in good condition or even alive would never occur to coolies or camp-servants, whose only thought is for themselves. They devote to their own use all the grain they can obtain either honestly or by theft, and would see fowls starve to death under their eyes rather than give them the minutest portion. Foraging on the part of the fowls in high regions with scanty vegetation or none at all, where grasshoppers, crickets, and other insects are not to be found, does not bring them spoils enough to keep them alive for long, and, if left to the tender mercies of camp-servants, they shortly die. If the traveller wishes to have the benefit of the fowls he takes with him, he must himself see that they are fed till killed for his table.

The Suru valley from Kargil to Suru runs in a direction practically south. Just beyond Suru it makes a wide turn around the end of a mountain-spur to the village of Purkutse at the base of the spur. From here it runs due east for twenty-three miles, under the name of the Upper Suru or Rangdum valley, and ends in an amphitheatre, into which four other valleys open. From Suru to Purkutse by the valley is a good day's march. A shorter





## SAVOYE DESPATCHED IN ADVANCE 21

and more interesting route crosses the top of the spur over the Purkutse La. This takes only about five hours, and affords an impressive view of the northern face of the Nun Kun massif.

We decided to approach the Nun Kun by the Shafat nala on its eastern side. As the mate and twenty-five coolies, who came with us from Kargil, were lying idle at Suru pending the return of our agent with others, Savoye and two porters were despatched on 26th June with twenty coolies to push up the Shafat nala as far as possible, find a suitable place for a base-camp, obtain as much information as they could as to the conformation of the region, and await our arrival with the main caravan.

On 28th Mr Hogg returned with thirty Kargil coolies in charge of the mate whom we had first engaged. The same day the Suru lambardar said many Suru coolies had returned, and he could supply us with thirty Suru men and a mate. It was apparent that these latter, learning that coolies were to be fed by us on the expedition and were besides to receive wages higher than those established by custom, were anxious to get a share of the

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bonanza offered, especially as they would be relieved of the expense of supporting themselves during the summer. From this time on, as the Suru coolies returned from the compulsory service for which they had been requisitioned, we had no difficulty in obtaining as many as were needed, and some who were again ordered away refused to go, remaining by preference with us.

On 29th June we left Suru with sixty-five coolies under three mates, thirty sheep, fifteen goats, and the dozen fowls, to cross the Purkutse La to the Rangdum valley. We were not pleased with the attitude of the Kargil mates. They seemed to take no interest in their work, and did nothing to make themselves useful or to further our interests or those of the coolies they had charge of. Their chief concern was, on one pretext or another to obtain an advance of money. Neither were the Kargil coolies satisfactory. They were slow in starting, took up their loads grudgingly, complained of their weight although they were not heavy, some being only thirty to thirty-five pounds, spent much time in rearranging them, and stopped to rest every sixty to a hundred steps. Their behaviour belied

what the Kargil Tehsildar said of them, i.e. that, having been half starved for two years, they were anxious for work and might be relied on to do faithful service. From the manner in which they started in we felt sure their sojourn with us would be short, for the work ahead demanded coolies with an entirely different animus.

We reached Purkutse at 1 P.M. and camped on the river-bank below the village, which is perched on crags above. Purkutse is the last village in the valley where any cultivation exists, and, as the amount of arable soil here is limited, every inch that is not rock is irrigated and planted. As a consequence we could scarcely find a dry place large enough for any of our tents, and were obliged to place them in any odd corner that presented itself. Here some of the Kargil coolies gave out, saying they were ill, and their places were taken by volunteers from the village, who remained with us throughout the expedition.

The next march of eleven to twelve miles brings one to some ruined stone huts, the remains of the former village of Gulmatunga. Opposite this place, on the south side of the Suru river, the Shafat nala



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enters the Rangdum valley. The path from Purkutse is good, though somewhat rough, for the first few miles leading over moraines, tali, and rock-shoulders. The first part is interesting because of the wildness of the Suru river, which reaches its noisiest climax shortly above Purkutse. For more than a mile the river-bank was strewn with blocks of white ice, and in the seething torrent hundreds of large ice-blocks were seen, which, as they tore along, lunging against rocks, were splintered and heaved into the air. Our voices were drowned by the roar of waters as we climbed the path, which wound over the cliffs overhanging this riotous, moving chaos of Nature. Turning a rock-buttress of a mountain-side one comes upon the explanation of the scene. Directly *en face* across the valley the riven, crevassed Ganri glacier makes its rapid descent from the Nun Kun. Without the intervention of moraine it plunges into the river in a sheer ice-wall 200 feet high. The layers composing its face scale off and fall as ice-blocks into the stream, which here flowing smoothly bears them slowly onward to join the ferocious current a short distance below. It is a suggestive and wonderful meeting of mighty





## INSUBORDINATION OF KARGIL COOLIES 25

forces continuing from year to year, this battle of the great glacier with the river, which its melting snows help to feed.

Distrusting the Kargil coolies, we allowed them to march ahead of us the greater part of the morning. As we glanced from time to time along the line in front, the fowls were seen at intervals on the tops of the loads, their fluttering wings outstretched in the attempt to maintain their equilibrium, like eagles on the standards of a moving army. At one o'clock the caravan, which had not marched with any enthusiasm, had covered eight to nine miles, when the fifty-five Kargil coolies went to one side in a body and sat down, laying aside their loads. On asking the meaning of this and telling them to go on and complete the march, they refused to do so, and said they would go no farther. As the road was good, they had been supplied with the full quantity of rations agreed upon, and we had had no words with them, their action in thus breaking their contract at the very outset was inexplicable, though we expected they would do so, as soon as any difficulties were encountered. The two Kargil mates, who were behind, now came up, and we demanded

## 26 PEAKS AND GLACIERS OF NUN KUN

of them, that they use their authority and make the coolies complete the march. This they would not do, but, siding with the coolies in their insubordination, said none of them would go farther and all would return to Kargil the next morning.

The Suru coolies took no part in the revolt, but kept by themselves awaiting the issue. On being asked what they would do, they replied they would stand by their agreement with us, and that the Kargil coolies were bad men, who could not be trusted, a fact which was sufficiently patent. As the march could not be completed with thirty men, much against our will, we were obliged to camp at this place. A messenger was immediately sent to our agent at Suru with instructions to send us more coolies as soon as possible. The next morning the Kargil coolies left in a body. In order that they might have no possible ground for complaint against us, and might have no occasion to say we left them starving in the wilderness, two days' rations were given to each coolie, although, of course, we were under neither legal nor moral obligation to do this. We afterwards learned, that, in thus breaking their faith, they acted under the orders of the Wazir of





## SURU UNFORDABLE AT GULMATUNGA 27

Kargil, the Kashmir Joint Commissioner for Ladakh and Baltistan, and highest native official of the region, whose reason for ordering this act of perfidy will appear later on. He was in office for what he could get out of it, and his actions during this summer so compromised his superiors that he was removed and sent to an obscure position in the plains.

We were detained two days at this camp by want of transport, and were obliged to weaken our force, so greatly diminished by the desertion, still further by sending five coolies with supplies to find and join Savoye. He had sent us word, that he was unable to ford the Suru river at Gulmatunga, as can usually be done in June and July, and had been compelled to make two long marches up the Rangdum valley to Tazi Tonzas, where he just managed to cross in the early morning, and then marched back again on the south side of the river to the Shafat nala. On 2nd July we sent on part of our luggage to Gulmatunga, two hours' march beyond the camp, and early on the 3rd sent another part, following ourselves with the balance as soon as the coolies returned.



## 28 PEAKS AND GLACIERS OF NUN KUN

We camped near the river. The next morning, taking a number of the bravest and strongest coolies and two ropes, we returned about half a mile to a point where the river widened, to see for ourselves whether a fording-place could not be found. The coolies were roped and sent into the water at several points to try it, but at all they soon got beyond their depth. It was evident we should have to march up the valley, as Savoye had done, in order to get across the river. This, in the crippled state of our transport, meant a delay of several days, which was most annoying, as, under ordinary conditions, we were only one day's march from the Shafat glacier, our first objective point, and we were anxious to improve the fine weather, which might at any time change for the worse.

The temperature had been unusually high for the season. Since leaving Dras the middle of June, we had marched in such sun-maxima, measured by our solar thermometer, as 191°, 196°, 199°, 200°, 204·5°, 205°, and 206° Fahr. The great heat had melted the snow on the mountains rapidly, and we had found all glacier-fed streams on our route turbid and greatly swollen, some of them being

impassable after midday. The Suru river was no exception. Its volume was much augmented and its mud-laden water of a dark slate colour. Further, the amount of water coming down was so great that it did not subside during the night to the usual extent, so that the prospect of being able to ford the river in the morning was not much greater than later in the day.

From Gulmatunga we moved slowly up the valley by half-marches, our coolies having to go twice over the ground every time we moved. We camped at the two small villages of Schama Karpo and Zulidok, where brushwood for fires can be obtained, but no supplies of any kind. At the former the chief Lama of the Gompa or Lamist monastery at the head of the valley, who was the lambardar of the region, joined us with five ponies, which formed a welcome addition to our transport-corps, especially as a Gurkha and fifteen coolies had to be sent back from Schama Karpo for coolie-food, reducing our force to five coolies.

At Zulidok, on 8th July, thirty-one coolies under the charge of the shikari arrived from Suru. They brought, among other things, a number of fowls,

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one of which was a good-sized cock, considerably larger than the white one. This reinforcement of our larder was first announced to us by a cloud of dust rising from the ground at some distance from our tents. Investigation showed it to be due to the following cause. The new cock, after being liberated by the coolies, was walking confidently towards the camp, when his progress was suddenly interrupted by the onset of the little white cock, which, having spied him and considering his own prerogative infringed upon by his presence, attacked him with great fury. The newcomer resisted stoutly, and the battle, which soon waxed fast and furious, lasted nearly an hour. The white cock, despite his disparity in size, proved the better bird, and his antagonist at length drew off and acknowledged himself beaten, his comb purple, lacerated, and bleeding, one eye entirely closed, and the other practically so. He withdrew to the confines of the camp, and, during the few days he was permitted to live, never again ventured within striking distance of the victor. The latter, although also severely handled, flying up on a rock and flapping his wings, announced his victory by a series of shrill crows,

and then rejoined his companions as if nothing had happened.

Although Zulidok lies fairly high, about 13,000 feet, with a cool, bracing air, and although the summer was only just beginning, we were here, as elsewhere in the upper half of the Rangdum valley, nearly devoured by mosquitoes from early morning till about noon, when the prevailing west wind, blowing down from the mountains, swept them away. They alighted rather slowly and silently and were easily killed. They were, however, persistent in attack, and while one might in a few moments kill a score, fifty others, unless one was wary, might succeed in biting.

On 9th July, with our force of thirty-six coolies and five ponies, equal to fifteen more, we started for Tazi Tonzas, a village about three miles above the Gompa, where, the Lama told us, Savoye had crossed the river. The valley here was covered with short grass, and flowers began to appear. Many marmots were seen sitting on the earth-mounds thrown up outside their burrows in the talus-fans projecting into the valley from the mountains, and they whistled merrily at us as we

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marched along, diving into their burrows on our nearer approach. The porters amused themselves by stalking them, but they did not succeed in killing or capturing any, as we had no firearms, and they could not get near enough to use effectually the stones carried in their hands.

The head of the valley widens out into a large amphitheatre, the floor of which is thickly covered with sand and water-washed stones and intersected by a number of mountain-streams all converging on the Suru river. From this amphitheatre four valleys lead into the mountains, down the most northerly of which we came in 1898 from Kharbu after crossing the Kangi La. In the centre rises a good-sized hill on which the Gompa or Lamist monastery stands, the abode of the lambardar-Lama already mentioned and a rabble of filthy, red-robed, younger lamas. A short distance west of the Gompa is a hamlet of half a dozen houses, where the chief Lama, who had left us two days previously, appeared, accompanied by a motley lot of half-Tibetan women bearing copper plates of meal in their hands, which they presented to us. When we had taken a pinch from each plate and





sampled it, they called vociferously in loud, laughing tones for bakhshish, on receiving which they returned to their houses.

As we passed the Gompa the lamas came out in a body and went through the same ceremony. An hour and a half later, on arriving at Tazi Tonzas, a dust-covered village of stone huts standing on a level stretch of sand, the chief Lama, who had disappeared from view at the preceding village, again greeted us with several women more fantastic in dress and appearance than the others, also with an offering of meal. As the novelty of this mode of reception had now somewhat worn away, we did not delay long in exchanging amenities with these ladies. Their importunity was quieted by a bakhshish of silver, and we addressed ourselves to seeking the least dusty spot on this sand-waste for our camp. The ponies now went back to Zulidok, and returned by evening with the remainder of our luggage.

For the last two days clouds had obscured the sky, which we regarded as a favourable circumstance, since the melting of the snow above would be lessened, and we might hope that the depth of



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water in the river would be diminished the following morning. That afternoon the porters investigated three of the six streams into which the river here divides, and found they were easily fordable. We tried to hire the five ponies for the return march to the Shafat nala, but the Lama said this would not be possible. They might assist us in crossing the river, but would go no farther. On this day one coolie had to be despatched to Suru with our mail and instructions to Mr Hogg, so that we had only thirty-five coolies to carry seventy-eight loads. We decided not to wait here for other coolies to arrive, but to leave forty-three loads at the village and push on with thirty-five loads of the most necessary luggage, so as to reach our base on the Shafat glacier as soon as possible and communicate with Savoye.

## CHAPTER III

Perilous Fording of the Suru River—Settling Accounts with the  
Lambardar—Countermarch down the Rangdum Valley—In the Shafat  
Nala—The Shafat Glacier—Desertion of the last Kargil Coolies.

WE left Tazi Tonzas at 7.20 A.M. The first five streams were passed without difficulty, but the passage of the sixth, the largest of all, proved quite a different matter. Although, as we had anticipated, the water was lower, it was still waist-high, ran with a rapid, eddying current, and was almost ice-cold. The stream was over 200 feet wide. True to his promise the Lama was on hand with the ponies, but with the river in its then condition crossing on their backs did not appear attractive. The authors crossed first. We preferred to trust ourselves to coolies, two of the largest and strongest of whom were selected to take us over. Armed with our bergstocks they stepped into the water, and we climbed upon their shoulders. As they advanced to mid-stream they swayed and floundered in the

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rapid current, stopping every few feet to secure their footing on the cobble-paved bed of the river, and to preserve their balance, while we clung to their shoulders and necks with all our strength, our feet and backs lashed by the cold waves, realising the insecurity of our moving perch and expecting every moment to be precipitated into the seething waters.

One porter tried a pony, and succeeded, after a perilous passage, in getting over alive ; but the others, after witnessing the animal's gyrations and desperate struggles to maintain his equilibrium, during which the porter, wet to the skin, had great difficulty in keeping his seat, concluded they did not care to cross in that manner, nor as we had done, but decided to trust to their own feet, wade over together in a line, and, supporting one another, buffet the billowy stream as best they might. They got over without accident, but thoroughly soaked and chilled.

Then came the twenty-six sheep and fifteen goats. A few of the sheep went over *à la nage*, as the porters, pleased with the prowess thus displayed, said, but others turned tail when pushed into the water, and made for the shore from which they started, so that they had to be dragged over by the coolies. As





for the goats, they shunned the water altogether, and the coolies had to play the part of good shepherds and carry them over on their shoulders. At the end of three hours all were landed on the farther side. The coolies collected a large amount of brushwood, and three fires were soon started, which, fanned by the wind, blazed and crackled fiercely and threw out a heat, that soon restored warmth and circulation to chilled limbs and dried the wet garments of all.

It took some time to settle the account with the Lama. A bakhshish of money, silk handkerchiefs, and a liberal supply of tobacco, had already been given him, but he did not hesitate to ask for more tobacco, and, in addition to payment for the ponies on the last two days, a bakhshish for each pony and pony-wala. In fact, the word bakhshish fell from his lips constantly during the half-hour of settling, and, as he rode away, it rang in our ears as long as his voice could be heard. He evidently wished to make the most of this unusual opportunity. He had really rendered Savoye and ourselves an important service, and we did not grudge him the pocketful of rupees he got from us before and after the river was forded. Let us hope he applied what he received

### 38 PEAKS AND GLACIERS OF NUN KUN

to the advancement of religion and to the promotion of the usefulness of the Gompa. He was, after all, of a jolly, good-natured sort, and, when we promised him more bakhshish on our return, he leered like a Himis mask. Fortune, however, ordered that we should return by another, much more difficult, route, and we never saw him again.

We now marched down the Rangdum valley on the south side of the river over rock-débris and swampy meadows to a point half-way to Gulmatunga. After considerable searching a small grass-covered spot was found dry enough to camp on, its surface, about six inches above the streams by which it was surrounded, just large enough to hold the tents. Here Swamp Camp was pitched. The mosquitoes hailed our arrival with a gusto, which showed that human beings were a rare article of diet for them. But their attack ceased soon after sunset, and they did not disturb our sleep, probably because the nights were so cold that, as was also the case with the mosquitoes on the Deosai Plains at about the same altitude, their activity was checked.

Resuming the march early in the morning we made our way over bush-covered swamps, boulder-

strewn sand-dunes, and finally over the face of a rock-cliff rising sharply from the river to the Shafat nala, which we ascended for three miles to a grass and bush-covered maidan in front of the tongue of the Shafat glacier, where we camped (Moraine Camp) at an altitude of 13,350 feet. The Shafat nala runs almost straight from the Rangdum, a little west of south, for nine miles, along the eastern edge of the Nun Kun massif, to the base of the splendid snow-mountain, marked Z1 on the Indian Survey map, which is seen through the nala from Gulmatunga walling in its end.

For about a mile above its outlet the bed of the Shafat nala consists of a succession of rolling hillocks sparsely covered with vegetation. These had been appropriated by a large colony of marmots as a site for a subterranean city, and their burrows pierced the ground at short intervals in all directions. These marmots were social in their habits and exchanged frequent visits, as was shown by footpaths, as distinct and well-trodden as any made by man, running between the different burrows and forming a network over the whole surface. Were this place of sufficient importance to have a name, it might



#### 40 PEAKS AND GLACIERS OF NUN KUN

appropriately be called Marmotville. For the next two miles the nala ascends gently in swampy meadows covered with grass and dwarf-willows, interspersed with three areas of rock and débris brought down by winter avalanches, and intersected by numerous swiftly flowing streams.

We remained five days at Moraine Camp awaiting the arrival of the rest of our luggage and supplies. The mate and thirty-five coolies were despatched to Tazi Tonzas for the loads left there. Meanwhile the Gurkha arrived with thirty loaded coolies from Suru, so that on the return of the mate and his band we had over sixty coolies, which number was sufficient for all needs, except on two occasions, when temporary coolies were easily obtained.

In the Shafat nala, as in the Rangdum valley, not a tree of any kind was to be seen. All about Moraine Camp and for 500 feet above on the hill-sides there was an abundance of dwarf-willow, which makes a good fuel. The sun here burned hot at midday, as it had done in the Rangdum. On 12th July the temperature of its rays at noon was 200° Fahr., and the shade-temperature was 63°.

The issuing of daily rations to sixty or seventy

## DISTRIBUTION OF COOLIE-RATIONS 41

coolies is an irksome task. They are not satisfied unless each sees his seer of satu or rice weighed, and assures himself that he receives full measure. This proceeding demands more time than the explorer himself can devote to it. If he, however, entrusts it to a native servant or coolie, he will find his stock diminishing more rapidly than it ought. We placed the distribution of coolie-rations in the hands of the Gurkha, who pitched his tent near those of the porters, who could keep an eye on what transpired, and, when he was absent, one of the porters took his place. It requires a person of phlegmatic temperament to endure the disputing and haggling of the coolies on such occasions. It is also necessary to be on one's guard, lest some of them, after receiving their portion, go away and dispose of it and then return at the other end of the line for a second portion, a trick almost certain to be practised on the unwary. Tea and tobacco we dispensed ourselves, these being luxuries for special occasions.

While waiting for the concentration of coolies and supplies at this camp we explored the lower six miles of the Shafat glacier. Its tongue ended half a mile above the camp in an irregular mass of ice

## 42 PEAKS AND GLACIERS OF NUN KUN

from eighty to a hundred feet high, stretching entirely across the nala and heavily covered with red granite-detritus, which gave it the appearance of a large terminal moraine. The valley-bed immediately in front of it, though somewhat strewn with small stones, bears no terminal moraine to indicate that the glacier has in recent times extended lower down than at present, to which fact the turf-covered alluvium, existing almost to the edge of the tongue, also testifies. Two good-sized streams issue, one on each side of the tongue, from deep gullies extending half a mile or more up the glacier. For the next two miles the glacier consists of a chaotic combination of high ridges, deep ravines with perpendicular walls, hillocks, and depressions, forming a labyrinth as difficult to traverse as could well be imagined. This part has no well-marked moraines either lateral or median, though it is covered with an enormous amount of detritus. Its banks on both sides consist of steep mountain-slopes greatly torn and eroded by ice and water.

The upper end of this portion ceases abruptly with a sharp sweep to the south-west, below which a lower surface of smooth, white ice about half a mile



#### 44 PEAKS AND GLACIERS OF NUN KUN

this section affords an interesting example of the application of glacial force. On its west side, about a mile above the lower end of the white section, a branch-glacier joins the Shafat. This branch is short, not over two and a half miles in length and perhaps half a mile wide, but, coming from the side of a high peak of over 23,000 feet, with a fall of 9000 feet, it presses with tremendous force upon the Shafat glacier. As a result the red section is crowded bodily over to the east side of the glacier-bed, cutting across the white section, forming a barrier to its further progress, and literally swallowing it up. Here the red portion expands so as to fill the whole glacier-bed, three-quarters of a mile wide, and forms the chaotic lowest two miles of the glacier already described.

The very abundant detritus brought down by the branch, seen in a large moraine it bears, is black. This crowds with the ice into the space on the western side, from which the red section has been pushed, and can be traced downward for about a mile. At the line of contact of the branch with the Shafat a large hillock of black material presses well into the red section, crowded high above the sur-





## THE UPPER HALF OF SHAFAT GLACIER 45

rounding level by the pressure. The eastern edge of the white section bears along a smaller black moraine, which is also swallowed up by the red portion at their meeting-point.

Opposite the face of Z1 the glacier, which thus far ascends with a moderate gradient S.  $23^{\circ}$  W., turns around the end of a spur of the Nun Kun, and pursues a course W.  $10^{\circ}$  S. to a ridge three miles above, running from the central one of the row of five southern Nun Kun peaks across the slope to an arête projecting from Z1. This ridge projects only slightly above the ice, but it forms a line of demarcation on the north side between the snows, which, coming from three peaks of the Nun Kun, feed the Shafat glacier, and those from the remaining two, which fall to the Fariabad nala; and on the south between those from the whole front of Z1 and those from it west of the arête, which also fall to the Fariabad nala. The altitude of this ridge at a point a quarter of a mile from the wall of Z1 is 16,911 feet. Thence it ascends continuously till it ends in a peak of over 21,000 feet.

The reservoir of the Shafat glacier differs from the ordinary type, in that it is composed of two lateral



#### 46 PEAKS AND GLACIERS OF NUN KUN

parts or wings, separated from each other by over two miles, the northern wing consisting of the slopes of the Nun Kun massif, and the southern of those of Z1, the snows from both of which descend east of the boundary-ridge into the intermediate depression, meeting near its middle line to form the glacier. The glacier is therefore destitute of a typical head or end-basin, enclosed by mountain-walls on the west. Its width just above the bend is about a mile, but below the ridge it widens to more than two miles, ascending sharply and greatly broken to the Nun Kun. The ice from the south or Z1 wing is remarkably free from detritus, but that from the Nun Kun wing bears a considerable quantity in detached masses, which finally become concentrated in the red western section already described.

Savoie's party had established a base-camp on the spur, around which the glacier turns, five miles above its tongue. The altitude of this camp was 15,100 feet, and it stood 400 feet above the glacier. They had with them seventeen coolies, of whom five were the Suru coolies we had sent to them with grain from our first camp in the Rangdum valley, and the rest were from Kargil. On the third





day after their arrival, two Kargil coolies, who had been despatched by the Kargil mates to apprise Savoye's coolies of the defection of their companions, having swum the river at Gulmatunga, appeared at the camp. They could give no proper account of themselves, but said we had sent them. On being asked for the letter, which every coolie who acts as messenger is expected to have, they could produce none. That night all the Kargil coolies deserted without warning, carrying off with them the body of a sheep killed that day and buried in the snow for preservation. Two of the five Suru coolies remaining became ill, so that Savoye was unable to accomplish much of the reconnaissance-work that had been planned. The loss of the sheep deprived the party of the whole of their supply of fresh meat, and other stores as well as the coolie grain were exhausted when we reached Moraine Camp. From this point we soon established communication with them and relieved their necessities.

## CHAPTER IV

Life at Base Camp—The Camp-Cock—Exploration from Base Camp—Nieve Penitente—Up the Ice-clad Flank of Nun Kun—High Snow-Camps—We enter the Nun Kun Plateau, above 20,000 Feet—At Camp Italia.

ON 17th July we left Moraine Camp with our whole caravan, and marched up the glacier to join the guide and porters at Base Camp. For more than a mile we followed the steep, torn, and boulder-covered left or west bank, and then descended to the glacier, where for another mile we picked our tortuous way over, up and down, in and out of, its rock-smothered ravines, hillocks, and ridges, to the smooth white ice, over which we passed without difficulty, till the crevassed red section adjoining the mountain-side had to be crossed, where care was necessary. A short, sharp scramble of 400 feet up the spur brought us to the camp. Two tent-terraces had been levelled off for us on the slanting hillside, upon which our tents were soon pitched,





while the porters and servants established their quarters as the nature of the ground warranted.

The coolies of the sportsman, who had visited this spot the preceding summer, had constructed several rude, stone shelter-huts near by, in which our coolies immediately made themselves at home. In a short time everything was arranged, and we devoted ourselves to preparations for the further moves to be made from here. All were now keen for snow-work. The nine small Mummery tents were unpacked and examined. A gross of long wooden pegs to anchor them were made from wood brought from the nala below. Ice-axes were tested and polished, and thick clothing was stowed in our clothes-bags in place of thinner garments heretofore worn. Extra mountain-boots were brought out and oiled, and those already in use re-nailed and repaired where necessary. The sound of pounding was heard for hours, for the porters were expert cobblers as well as cooks.

The camp was well above the wood-line. Nothing, not even a shrub, grew that could be used for fuel. Twenty coolies were sent down daily to the nala below the glacier to fetch wood for fires and tent-



## 50 PEAKS AND GLACIERS OF NUN KUN

pegs, and soon a large amount was accumulated ready for use. Grass, plants, and flowers, however, covered the whole slope, to the great delight of the goats and sheep, which roamed about at will, nibbling eagerly throughout the day, and to the satisfaction of the servants and coolies, who used two varieties of a soft, thick-stemmed plant as a salad, and revelled in the wild onions as seasoning for their food. Forget-me-nots, purple asters with brilliant orange centres, edelweiss, crimson orchids, and many other flowers grew in profusion about our tents, and we had all the pleasure of a garden without the trouble of cultivating it. In Himalaya, where edelweiss grows like a weed, there is no occasion to commit suicide by falling over a precipice in attempting to pluck it, as so many incautious persons do each season in the Alps.

Whether the sportsman referred to found any large game here we did not learn. We saw no foxes, bears, ibex, nor other large animals, nor their traces, though in Baltistan at similar altitudes we had met with bears and seen hundreds of ibex feeding on high slopes. Eagles often circled above, and a large one, after keen espionage, succeeded in



## 52 PEAKS AND GLACIERS OF NUN KUN

himself at home, walked around with as lordly an air, and crew as lustily as if he had been the most beautiful bird in existence. Here, as elsewhere throughout the journey, his ringing voice awoke the mountain-echoes at the earliest glimmering of dawn, and continued at intervals till night had drawn its deep shadows about the camp. It cheered us whenever we left to make reconnaissances, and was the first sound to greet us on our return. Our Kashmiri khansamah said of him, 'He talks all the time.'

He did not appear to be disturbed by the rapid diminution in the number of his companions, and when, at last, the number was reduced to one, his demeanour remained unchanged, and he devoted himself to looking after her welfare with the same assiduity as he had displayed when there were a dozen. The hen made a nest in the khansamah's tent and went in daily to lay an egg, during which time the cock waited patiently outside till she reappeared. He won our respect on account of his dauntless courage under all the maltreatment he had been subjected to on the march, thus furnishing us with an excellent example in the face of dis-





couragements, that had threatened the success of the expedition. We came to regard him as our bird of good omen, and could not bring ourselves to devote him to the fate for which he was purchased. The hen also was spared to be a companion for him.

The camp commanded a grand and unobstructed view of the wild, steep front of Z1 directly opposite, over 22,000 feet in altitude, after the Nun Kun the highest and most imposing massif in the region, clad in a shaggy mail of ice, portions of which every now and again broke away and plunged downward to the glacier in resounding avalanches of deadly magnitude. From an upper plateau at about 20,000 feet two snow-cones rise, which would probably be climbable could they be reached, and the view from them would be of great topographical interest. Unfortunately, as in the case of many alluring Himalayan peaks, the approach to them was cut off by the inaccessible, avalanche-swept precipices before us, and careful examination failed to disclose any route that promised a safe or successful ascent.

Extending east from Z1 is another ice-covered wall ending in a handsome pointed peak, beneath which an eastern branch-glacier descends to the

## 54 PEAKS AND GLACIERS OF NUN KUN

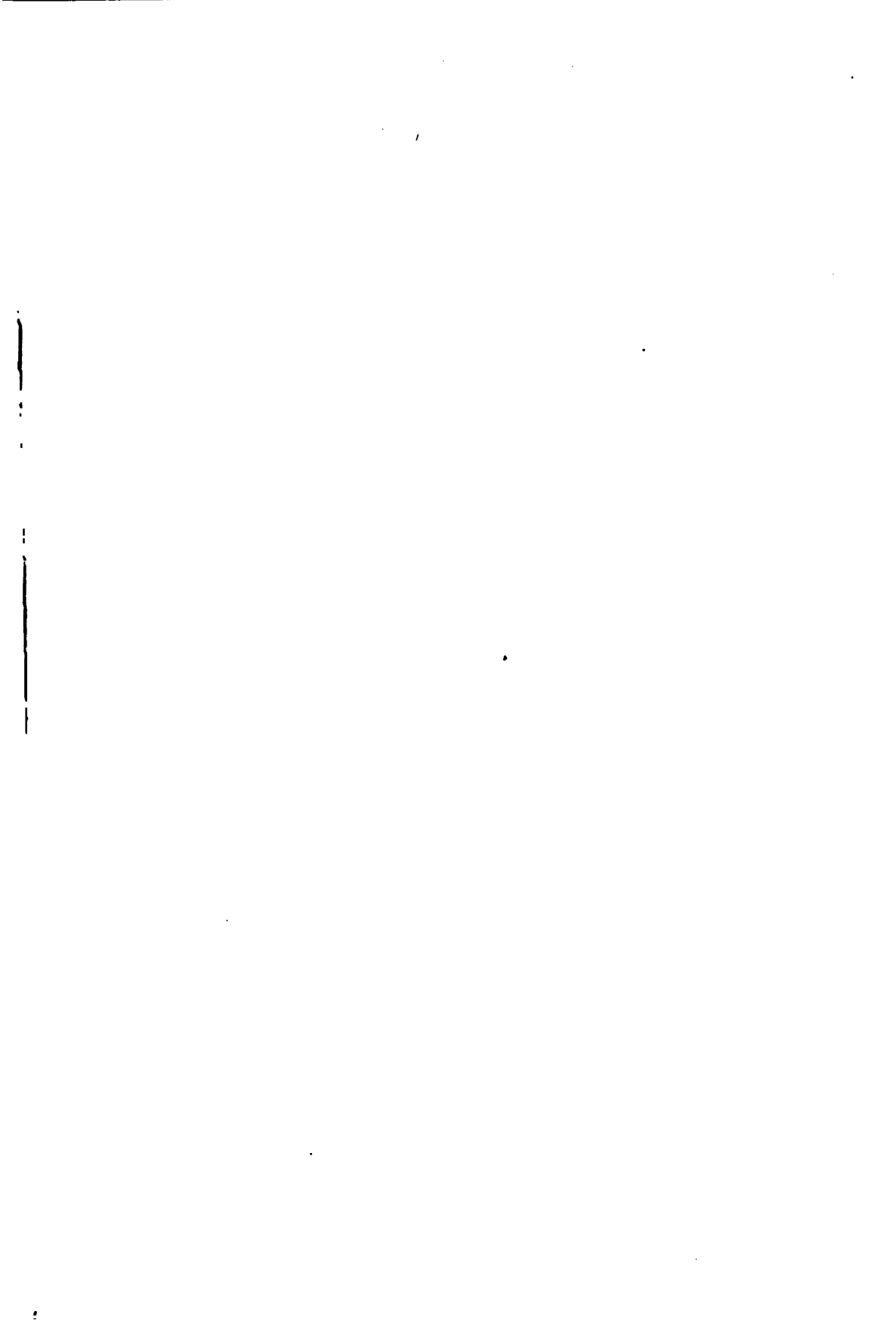
Shafat in a much broken ice-fall covered with séracs. We named it Ice-Fall Branch. One day was spent in investigating the mazes of the ice-fall. We went down from the camp to the glacier, crossed the red section where it first takes definite shape, off the point of the spur, and after this a depression covered with short moraines and much detritus in slabs, through the centre of which a good-sized stream ran from the glacier above, and then mounted to higher ice, beyond which lay the foot of the ice-fall. Here we soon became involved in a labyrinth of séracs separated by crevasses and chasms, up which we found our way to a height of 15,675 feet. Here the view of the broken ice-cliffs above, below, and on each side, was most impressive, and beyond these we could see north down the whole length of the Shafat glacier and nala to Gulmatunga, and west up the Shafat glacier to its head at the ridge, and also the southern line of Nun Kun peaks, the slopes of three of which form the northern reservoir of the Shafat.

The Shafat glacier was also descended, and a reconnaissance made up its lower, west branch with a view to finding a passage from its northern head











through the mountains to Suru, but steep, ice-covered walls prevented any passage in that direction.

On another day we ascended the Shafat glacier to the ridge forming its western boundary. Crossing the end of the spur below the camp we descended to the glacier on its west side, reaching the ice after traversing a depressed, débris-covered space and climbing over a lateral moraine. The ascent of the glacier, with gradients varying from  $30^{\circ}$  to  $50^{\circ}$ , was not difficult. Care, however, was necessary to avoid crevasses, which cut its middle portions in various directions. We reached the ridge on the south side of the glacier at the extremity of the arête projecting from Z1, the top of the ridge being at an altitude of 16,911 feet. This is composed of a great accumulation of slabs and laminated rocks lying, apparently, on a more solid rock-foundation. We named it the Fariabad Col. Between this and the extremity of the ridge projecting from the Nun Kun is an interval of several hundred feet, through which we ascended to a glacier west of the ridge, which, falling from the two westerly of the five southern Nun Kun peaks almost due south, nearly at a right angle with the course of the Shafat, descends to the Z1 nala

## 56 PEAKS AND GLACIERS OF NUN KUN

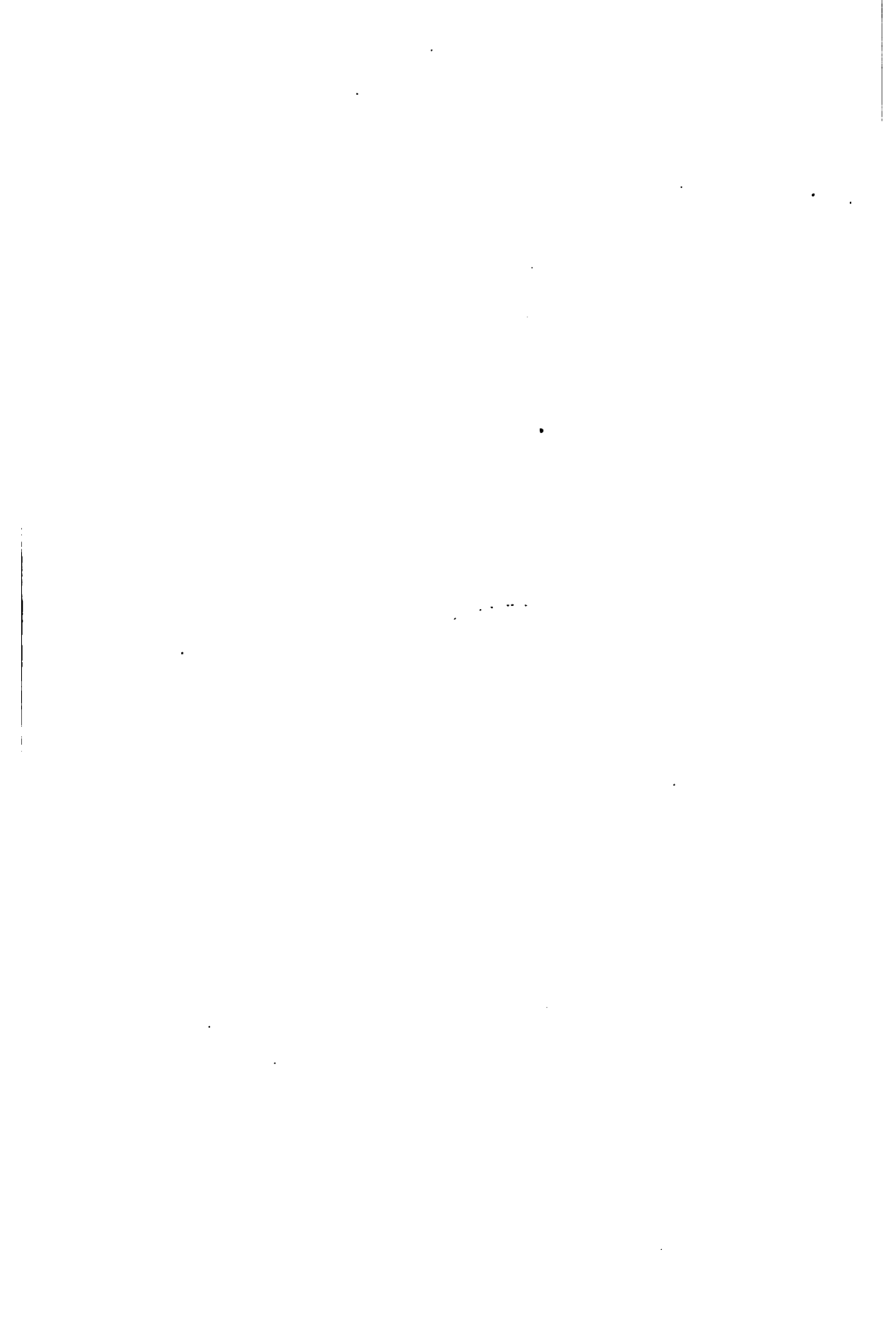
a short distance above its junction with the head of the Fariabad nala. This we named the Fariabad glacier. It contributes a small quantity of ice to the Shafat glacier through the opening. We reached a point on it 17,336 feet in altitude directly west of the opening, where we were stopped by impassable crevasses.

A reconnaissance was also made of the north reservoir of the Shafat on the side of the Nun Kun massif to an altitude of over 19,000 feet, which disclosed some of the difficulties of climbing on this side. From these investigations an excellent idea was obtained of Z1, of the eastern branch-glacier and its ice-fall, of the Shafat glacier and its basin, and of the Fariabad glacier; but from no point could we see the conformation of the highest part of the Nun Kun massif, lying behind the five southern peaks crowning the wall above Base Camp, nor could the relation of the highest south-western peak to its neighbours be determined, nor were the two northern peaks next in altitude visible, except the extreme tip of the second-highest at the north-east end, which was visible from the ice-fall under Z1.

Large portions of the *névé*-surfaces of the upper











third of the Shafat glacier, at altitudes of from 16,000 to 18,500 feet, were thickly covered with nieve penitente, giving the glacier in places the appearance of a sea of crested snow-waves. The pinnacles varied in height from eight inches to three feet, and had the shape of wedges and of pyramids flattened at the sides, many with curling-fluted crests all turned in the same direction. They were arranged in parallel lines running in the same direction as the slope they stood on, the long diameter of each pinnacle being parallel to the long diameters of others in the system and coincident with the direction of the lines.

They were composed of granular névé, hard frozen in the morning, but softening somewhat under the heat of the sun. The central portion of each, even when softened by the sun, was much denser than the outer surface, offering, even in the case of the smallest, decided resistance to the thrust of an ice-axe, when the surface and the névé between them could be scraped away with the fingers. The névé between them sloped at angles of 30° to 40°.

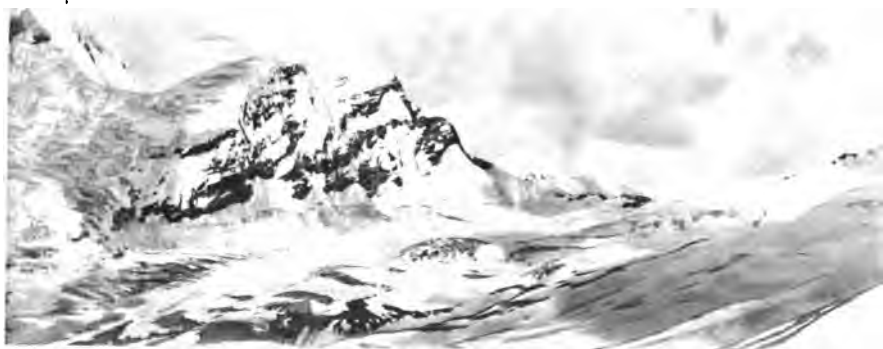
Later they were also found on two snow-peaks several miles farther west at altitudes of from

## 58 PEAKS AND GLACIERS OF NUN KUN

18,500 to 20,500 feet. On these peaks they were larger and on the highest were composed of ice, this transformation being due to the water resulting from the melting caused by the fierce heat of the sun sinking into the névé of the pinnacles and freezing as soon as the sun set. This was the first time in five seasons of Himalayan exploration that we had met with them, and we are not aware that their existence in Himalaya has been mentioned by any other observer. More will be said of this formation later on.

The glaciers and lower heights having been examined, Savoye and two porters with a number of coolies were sent to make a three-days' reconnaissance on the high slopes above the camp as a preliminary to the investigation of the highest parts of the Nun Kun massif. This disclosed, among other things, a projecting rock-promontory about 2500 feet higher up with screes at its foot, where coolies could make fires and pass the night; and about 2200 feet above that, among the ice-falls at the base of a snow-needle, a small sloping snow-plateau, which the coolies, by starting early from their night-bivouac, could reach in time to return





*Panorama of reservoir of Shafat glacier from mountain above Base Camp. Orographical left, or north part, descend. Glacier has no proper head or end basin on west, being bounded by a*

1000

1000

1000



to the latter the same day. This was the highest point at which they would be available, as no water nor rocks existed here or higher.

Basing our plan of attack on the upper portion of the massif on the existence of these two *pieds à terre*, we caused a supply of wood and food to be forwarded to the promontory, which was to serve as a secondary base, and, two days later, four porters with coolies were sent ahead with extra outfit for the higher regions, with orders to remain overnight at the promontory, move up the next morning with coolies and supplies to the snow-plateau, and make a second camp there, sending the coolies back to us. From here they were to push on, establish a third camp or a cache with extra Mummery tents at the highest available point, and then return to and await us at the second camp.

On 25th July, two days later, with Savoye, two porters, and fifteen coolies, we followed, ascending for an hour over great moraine-masses, and later over tumbled and crevassed slopes of ice and snow lying between the giant rock-ribs descending from the peaks above. Many *nieve penitente* pyramids were met with, some of them of large size. About



## 60 PEAKS AND GLACIERS OF NUN KUN

noon a snow-hollow near the base of the promontory, where a large pile of brushwood and traces of the porters' camp were seen, was reached. Here we pitched our camp on the snow at 17,657 feet, and named it Nieve Penitente Camp. The site was a fine one and commanded a view of the grand, east ice-fall overtopped by tall, sharp peaks, and west of this a complete picture of the imposing rock and ice-bound massif of Z1. The coolies, after depositing their loads, betook themselves to the rocks, where their tent was speedily spread and a blazing fire lighted, which kept them warm through the afternoon and night. We passed a comfortable night and slept well, and it was fortunate for future work that such was the case, for it was the last time in five nights that sleep was to visit our eyelids. The minimum temperature was 17° Fahr.

The next day our route led us at first up a sharp snow-wall, which, after steps had been cut, was well managed by the coolies. Then came long snow-slants broken by deep crevasses and huge icicle-lined schrunds. After these the slopes were more gentle, and for a time the caravan moved with fair speed. But soon they became wilder, steeper, and more



the first of these is the fact that the  
the second is the fact that the  
the third is the fact that the

the fourth is the fact that the  
the fifth is the fact that the  
the sixth is the fact that the

the seventh is the fact that the  
the eighth is the fact that the  
the ninth is the fact that the

the tenth is the fact that the  
the eleventh is the fact that the  
the twelfth is the fact that the





## ARRIVAL AT WHITE NEEDLE CAMP 61

broken, and with the altitude, now making its effects rather marked, they made us realise that, having accepted the challenge thrown down by the Nun Kun, we had rugged work before us. The coolies marched valiantly, although halting often to rest and breathe. To this point we saw no signs of the advance-porters, but, on surmounting several other broken slants, we spied three of them descending a steep snow-wall far above, appearing like black dots on the background of pure white. As we got still higher we saw, what is seldom seen ahead at near 20,000 feet in Himalaya, refuge-huts, three tiny green tents with bags stacked beside them. On we pushed, and in due time reached them, standing on the small, sloping snow-plateau at the base of a beautiful snow-pyramid crowning the extremity of a short eastern spur of the highest Nun Kun, which we christened White Needle Peak.

One porter and one tent-servant were waiting for us, and in an hour the three other porters joined us, returned from a tour of the heights above. Our tents were soon added to those already placed, and the camp was named White Needle Camp. Its altitude was 19,900 feet. On arrival some of the

## 62 PEAKS AND GLACIERS OF NUN KUN

coolies were mountain-sick and threw themselves on the snow, and nearly all were suffering with headache. They had stuck to their work and completed it, giving us little trouble on this high and difficult march, and complaining much less than Balti coolies had done under similar circumstances. They were allowed to leave at once for Nieve Penitente Camp. Previous to their departure we asked, whether any of them would remain overnight and go up to the next camp. Two, who volunteered to do this, were assigned quarters in the tent with the camp-servant. They, with him, made three extra porters, which addition to our force was of considerable advantage to us on the next day's march to the third high camp. Suru men seem to have more courage and endurance and to be better disposed than Baltis. Many of them approach the Ladakhis in type, which may account for the difference.

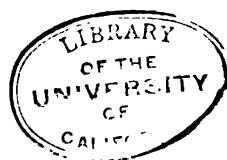
A short distance behind the camp rose a ragged, dangerous-looking ice-wall, from which, at intervals, great icicles were broken away by the wind and hurled down in dangerous proximity to the tents, while 200 feet distant below yawned a wide berg-











## VIEW FROM WHITE NEEDLE CAMP 63

schrund. The view from here was grand and entrancingly beautiful. Above, around, and below, lay a chaos of broken ice-walls and glaciers in cold white and blue. Directly in front, across the open space, rose the imposing mass of Z1, the dominating feature of the scene; and beyond this, in the background, rolled wave after wave of distant Zaskar snow-peaks clad in chameleon robes of crimson, mauve, and gold, as the sun poured its sheen of light upon their dazzling flanks.

This camp was 550 feet higher than our highest Chogo Lungma camp in 1903, and a trying night was anticipated, for one suffers more from rarefied air when in the recumbent position. In this we judged correctly. Not one of the nine Europeans obtained much sleep during the long, dark hours that followed. To add to the discomfort of sleeplessness, a strong wind blowing in gusts shook the tents throughout the night, causing us to fear we might be carried down with them into the bergschrund below. The minimum temperature was 17° Fahr., the same as at Nieve Penitente Camp.

The next day's march was not long, but it was trying to the nerves. We had first to scale the ice-

## 64 PEAKS AND GLACIERS OF NUN KUN

wall above the camp, and then ascend over a long, snow-covered ice-slant with a convex surface inclining from  $50^{\circ}$  to  $60^{\circ}$  at different points, separated from an ice-wall beneath by a wide bergschrund, which ran along its whole base. The Europeans advanced in two roped caravans, the forward one using a light half-silk rope tested to a strain of 1000 kilos., which, even when doubled, is much lighter and more flexible than the ordinary manilla Alpine rope. The second caravan used the manilla rope. The guide, porters, and three natives, carried loads of from thirty-five to forty pounds. There was no necessity for step-cutting, as the porters on their previous ascent had made a sufficient, though narrow, path.

We attacked the wall immediately after starting, making short and frequent halts for rest and breath, as we trod silently the white ladder of approach to the mysterious unknown. Above this came the long ice-slant, which we traversed diagonally in a straight line to its top. Here the direct path was not so steep, being only about  $35^{\circ}$ , but the sharp incline of the whole slant from above downwards made the traverse fatiguing, as during the halts











we could not sit down, but were obliged to stand upright in the narrow steps, which tires the feet and legs more than advancing. A misstep here might hurl us into the bergschrund just below, or, if we passed that, down gruesome precipices to the glacial ice-fields thousands of feet below. It was well for us that the ice of the slope was covered with two feet or more of snow, which was probably frozen to it, for two or three weeks later, when the snow had melted or been shed in avalanches, the slope would become too dangerous to attempt.

The mental strain of such a prolonged, dizzy climb at over 20,000 feet is intense. One does not so much mind this sort of thing when moving steadily for a short time with unloaded guides in the Alps, but in a place like this, where halts have to be called every few minutes, and there is plenty of opportunity to observe and realise one's precarious position, the longer time occupied suffices to create considerable nervous tension. Although our movements were measured, we soon distanced the servant and coolies, who fell far in the rear. Finally the slant became more gentle, and then ended in a snow-crest lying at an altitude of about 21,000 feet.

## 66 PEAKS AND GLACIERS OF NUN KUN

Up to this point we had seen nothing of the highest part of the massif except the tops of some of its peaks, but on reaching the crest we found we were standing, not on a col between the first and second of a straight line of peaks, as the Survey map and previous statements had led us to expect, but just above the brow of a glacier emerging from a dazzling white snow-plateau or basin, some three miles long by one and a half wide, enclosed by six great peaks and one smaller one, which encircle it in a tiara of great beauty. The highest peak of all rises by itself directly from the ice of the plateau, unconnected with any of the others by cols. If the snow-summit we have called White Needle Peak, on the flank of which we here stood, the altitude of which we judged to be from 21,800 to 22,000 feet, be counted as a separate peak, as might fairly be done, then the number of peaks enclosing the plateau may be considered as eight. As, however, this summit crowns the end of a short spur of the highest peak, we have not included it in the number given.

How wonderful are the revelations of Nature in the Himalayan Ice World! Here was suddenly spread before our astonished eyes such a formation





as we had never seen before, and, from the scanty information previously available, could scarcely have been imagined to exist at this spot, one which upset all preconceived ideas of the topography of the Nun Kun. In this high vale of snow, at an altitude 5000 to 6000 feet higher than the summit of Mont Blanc, we were destined to spend three nights.

A short distance ahead in the basin, about 400 feet below where we stood, three Mummery tents were seen planted in the snow, adding a note of human interest to a scene otherwise of unearthly beauty. Having examined the surroundings we descended to the tents. Before they were reached clouds came over the mountains, and a flurry of snow overtook us. The tea and water in our flasks being exhausted, a halt had to be made to melt snow to re-fill them. While this was being done, as the weather continued threatening and the snow had become too soft for marching, we decided to pitch the remaining tents beside the three already placed and camp there. This our third snow-camp was at 20,632 feet. It was named Camp Italia, as the guide and porters passed two nights here. If any snow-leopards were prowling about, they must have

## 68 PEAKS AND GLACIERS OF NUN KUN

viewed with some curiosity the scene which ensued—men engaged in pitching tents, lighting stoves, preparing dinner, setting up cameras, making observations, and doing other things which showed, that this uppermost plateau in the very heart of the Nun Kun had been successfully invaded by human beings.

After a time the three natives came up and flung down their loads as if glad to be rid of them. The two coolies made deep salaams in the snow, and gesticulated in an animated manner in the direction of two peaks peering out of the clouds. They, evidently, thought it advisable to propitiate the mountain-deities after their stiff climb and court favour for the dangerous return-journey. A week later, probably as a result of what they told on their return, the report went out that we had climbed the highest peak, and hundreds of persons in the different villages are said to have declared they had seen fires burning at night on its summit. By the rules of evidence the concurrent statements of so many witnesses of the fires ought to be sufficient to establish the fact of their existence, and hence the truth of the report. On their face these statements should,











certainly, be as worthy of acceptance as those of various groups of individuals, whose concurrent testimony, at various times, as to the perception of other hallucinations of sight and sound has been accepted, both in religious and secular literature, as proof of the reality of such hallucinations,—and yet the fires seen on the mountain existed only in the imagination of those who saw them. It would be an intrepid, cold-proof mountaineer indeed, who could take up fuel and light a fire on any of those great peaks of a night.

The coolies having completed their religious exercises presented themselves before our tents, asking permission to go down and begging a bakhshish. A coolie would probably use his last breath in begging for bakhshish, if he were to reach the top of Everest alive. This was promised on our return to Base Camp, which satisfied them, as they had learned by this time that we always kept our promises, an important thing when dealing with coolies, who trust the word of no one of their own kin. They were despatched to Camp Nieve Penitente with the camp-servant, who was instructed to bring up thirty coolies to White Needle Camp, as

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soon as a porter should come down with an order from us. As they moved away, we realised that their departure severed our last link of communication with the world below, and that we must now depend, in any future move, entirely on the efforts of the little band assembled on this isolated snow-plateau.

The storm-god, as if to show his disapproval of our invasion, treated us alternately to mist, snow-squalls, and sunshine, but finally, finding our intentions pacific, ended his weather pageant by a golden sunset. With the guide we studied the basin and the peaks enclosing it. The outlines of the highest, rising 2800 feet above the camp, could be clearly seen from plateau to apex. The last 1000 feet, spreading out in a broad surface, appeared climbable, but to reach this, 1800 feet of sharp wall and knife-edge arêtes rising at angles of 70° and over would have to be passed, which were deemed impossible for men carrying loads, and which, if passable at all, would tax to the utmost the skill of unloaded experts. Besides, owing to altitude and the technical difficulties presented by the peak, one, and, perhaps, two camps would have to be made, for





which no suitable place was discoverable; so we decided to move the camp the next day up to the farther and higher north-east end of the plateau at the foot of the next-highest peak, about 150 feet lower, which, rising in one steep, much-broken ice-slant, appeared to offer a better, though by no means certain, chance for an ascent.

A pair of choughs flew over the camp late in the afternoon, and disappeared between two sunset-tinted peaks. These were the only living things seen here. They were flying at an altitude of about 21,000 feet. This is the highest altitude at which we have met with them. Ten days later one was seen from the summit of D41 flying below it at about 20,000 feet. After a short twilight a moonless night of impenetrable darkness set in, and all betook themselves to their sleeping-sacks, each to solve the question of getting through the next, sleepless ten hours as best he could. The minimum temperature on this night was 4° Fahr.



## CHAPTER V

*Alone at Camp America, 21,300 Feet—Ascent of Pinnacle Peak, a Record-Ascent for Women—The Descent to Base Camp.*

ON arrival at Camp Italia one porter complained of loss of appetite, giddiness, and weakness. He crawled into his tent as soon as possible, and nothing more was seen of him that day. Owing to his illness, it was evident that there were not men enough to carry the necessary outfit to the next camping-place at the upper end of the plateau, so it was decided to first take our tents, instruments, and kit, and as much of that of the porters as possible, find a suitable place and pitch the tents, after which the guide and porters would return for the balance. At daybreak the frozen tents were taken down and packed, and we started. The porter who was ill had not recovered sufficiently to carry a load, but he set out with us. After a short distance he gave out and returned to Camp Italia. He will be referred to later. There was a descent of a few





hundred feet towards the centre of the plateau, followed by a continuous ascent at 20° to 30° over an undulating surface to its upper end, three miles distant.

From this plateau the Nun Kun peaks did not appear so impressive as their altitude would lead one to suppose, or as those that can be seen appear from the region outside. We had been climbing on the massif for three days to reach the plateau, which was not so very far below their summits. Also, owing to the curves of the plateau, which concealed a part of their height above it, and to foreshortening of their slopes by proximity, they seemed lower than they really were.

When we reached the upper end of the plateau, a place secure from avalanches was chosen, not far from the base of the second-highest peak, where our two tents were pitched. By this time the snow had become soft, and mist was settling in as on the preceding day, so that it seemed doubtful, whether the guide and porters would be able to return to us with their kit that day as planned. It was therefore arranged, that they should go down to Camp Italia and bring up their tents that afternoon, if weather

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and snow-conditions allowed. Otherwise they were to sleep at Camp Italia, and those selected to go higher should rejoin us at daybreak.

Soon after they departed the mist settled in thick around us, concealing the plateau and surrounding summits from view, and did not lift till near sunset. When the mist fell, it became evident, that we should have to pass the night alone in that untrodden solitude of snow. We did not fancy the prospect of being left in such a place, at such an altitude, cut off entirely from all communication with the outer world, in weather which appeared to be uncertain, and in a temperature which, though now too warm for comfort, was sure to fall to or below zero before morning, but this contingency had to be faced. We unpacked the instruments, provisions, and coverings, and made ourselves as comfortable as circumstances permitted.

The afternoon was windless and oppressively hot. The sun shone through the drifting mist with a sickly light, but with a heat, that sent the mercury in the solar thermometer up to 193° Fahr. at two o'clock, and to 142° at half-past three. The heat was equally unbearable within and without the





tents, and all the harder to endure because of the mist, which, while shutting out all view, shut in the heat, so that it became a palpable entity penetrating to every part of the system with depressing effect. Finding no protection from the heat inside the tents, we enveloped our heads in wet towels and proceeded to make readings and observations outside.

We named this camp Camp America. Its altitude, measured by the boiling-point readings taken compared with simultaneous ones at the lower Government station at Dras, thirty-four miles distant, where readings were taken for us three times daily during our absence, was 21,300 feet.<sup>1</sup> The same readings calculated by Airy's table make its altitude 21,600 feet, which, if Airy's table can claim greater accuracy than other tables, may be regarded as

<sup>1</sup> In this, as in all other cases, to ensure accuracy two readings were taken of each of two tested boiling-point thermometers. In taking readings, if any discrepancy in the registration of the thermometers occurred, the process was repeated with every care. The two thermometers, which were certified to have no error, always registered together under the same conditions, any variation being found to depend on some difference in manipulation.

During previous expeditions four thermometers were often used, one of which had a slight plus error, on applying the correction for which the readings of the four coincided. On this expedition, as two without errors answered the purpose, the others were discarded as superfluous.



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the correct altitude. As the variation is so great, and Airy's table differs from others in placing sea-level at thirty-one inches and in giving relatively higher altitudes for very low pressures, the results of calculations by it have not been quoted for our altitudes.

In either case this camp represents, we believe, the highest point up to date, June 1909, with possibly one exception, to which tents have been taken and occupied, and the highest measured point at which mountaineers have passed the night. Dr T. G. Longstaff has asserted several times in print (*vide the Geographical Journal*, Jan. 1908, p. 41), on very insufficient grounds, that Mr W. H. Johnson, while in the employ of the Indian Survey, camped in 1864 in the Kuen Luen mountains at an altitude of 22,000 feet.

The existing evidence in support of this assertion is of a most shadowy character. The authors, after careful examination of Mr Johnson's published reports, have been unable to find any statement by him, that he had camped at any altitude which he thought approached 22,000 feet, and no one else has been able to cite any statement by him to this effect.

The only allusion to such a camp by a contemporary of Mr Johnson appears to be a remark by Colonel Montgomerie found in the *Journal* of the Royal Geographical Society, 1875, p. cxiv, where he says that, 'He (Mr Johnson) actually forced his way over (a ridge of 22,300 feet) and was obliged to spend the night at nearly 22,000 feet, darkness having come on before he got any lower.' His authority for this remark is not given.

Mr Freshfield, in a carefully worded summary of the contradictory evidence regarding Mr Johnson's high climbing, in the *Alpine Journal*, August 1884, pp. 58-59, writes, that he was told by Mr Drew, Mr Johnson's companion in Ladakh, that in conversations with him Mr Johnson referred to the altitude of the ridge in question as exceeding 22,000 feet, but 'he did not profess to have taken any measurement which enabled him to estimate other than by comparison the height of the ridge crossed.' No camp is mentioned.

Such evidence is, certainly, insufficient to warrant the categorical assertion, by one having no personal knowledge of the events or persons connected with them, that Mr Johnson camped at 22,000 feet.

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Two parties have recently claimed to have bivouacked without tents at greater altitudes, Mr Reginald Rankin having been overtaken by darkness on his descent from Aconcagua in 1902 at an elevation which he estimates at 22,000 feet, and Dr T. G. Longstaff having stated that he, with guide and porter, passed a night in the snow, with no other coverings than the clothes they were wearing, at an altitude which he thinks was 23,000 feet. It may be noted that, in the last two cases, the altitudes claimed were not determined by any kind of measurement, and, being only estimated, cannot be placed against measured ones.

The possible exception referred to is the highest camp of Messrs Monrad Aas and Rubenson on their ascent of Kabru, which they place at 'about 22,600 feet.' This altitude is based on aneroid readings, apparently not compared with simultaneous ones at a measured lower station, and the aneroid not being checked by boiling-point observations. Hence it can scarcely be regarded as more accurate than an ordinary estimate. From the account given by Mr Rubenson in the August 1908 *Alpine Journal*, it appears, that three high

camps were made, and it is a loss to mountain-science that the altitudes of these could not have been determined with greater exactness.

Estimates of altitude, like those of other things, are unreliable, approaching the reality by a longer or shorter distance according to the ability and experience of those making them, but in no case should they be made the basis of exact scientific deductions. In order to place mountaineering on a scientific basis, the necessity of the measurement of altitudes reached by one of the methods recognised as fairly reliable is evident, since such measurement alone defines with approximate exactness, irrespective of guessing on the part of any one, the height at which observed altitude-phenomena may occur, and without it observations lose an important part of their value. We mention this subject thus at length on account of the practical importance attaching to the connection of certain observations on altitude-effects, which will be presented in the following chapter, with high camps, the altitudes of which were measured by most careful readings in accordance with a well-recognised method.

Dinner towards sunset was a simple affair. The

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appetite is quickly satisfied at such an elevation. After a light meal of soup, biscuit, and tinned meat, we went out to enjoy a never-to-be-forgotten scene. Every sign of mist and threatened storm had vanished. High in the west above the mountain-tops hung a bank of cloud suffused with crimson. Everywhere else the sky was pure steely blue, into which the septette of great peaks rose in solemn majesty in the weird crepuscular light. It was indeed a Dämmerung of the mountain-gods, different in meaning from Wagner's *Götterdämmerung*, yet filled with the same spirit as that which inspires his finest Nibelungen music, the deep significance of Nature. For what has Nature more truly significant than the great icy mountains and the star-sprinkled sky? Our small camp was but an atom in the wide arctic basin, now ashen in tone from the falling night. The air was silent with that mountain-stillness more potent than speech. But we were human, and the cold penetrated our vicuña-coats as, leaving the ice-wilderness to the fast-encompassing pall of darkness, we turned shivering into our tents.

At sunset the temperature fell to freezing, and an hour later to 10° Fahr., reaching a minimum of

## SLEEPLESS WATCHES OF THE NIGHT 81

- 4° before morning. It thus underwent a variation of 197° in somewhat more than twelve hours. The night seemed the longest, and it certainly was the coldest, we had ever passed in camp. No sleep came to break the dragging hours, as we lay panting every few moments for breath. As we had found before under similar circumstances, the absolute silence that reigned during the watches of the night, in the absence of sleep, proved almost as nerve-wearing as an excess of noise. In such a situation one has the feeling of having completely lost touch with the material world, and the imagination, uncontrolled by the suggestions of ordinary sounds, runs riot among fancies and possibilities neither wholly pleasing nor reassuring.

When we sought to quench our thirst, the water in the flasks was found transformed into solid ice. At last, after what had seemed at least twenty-four hours of darkness, a shade of grey dawn penetrated the green tent-canvas, and soon steps and the click of ice-axes were heard on the frozen surface outside. On putting our heads out of the tent-flaps we were greeted by Savoye and two porters, who, with red eyes, purple faces, and moustaches fringed with

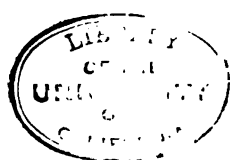
## 82 PEAKS AND GLACIERS OF NUN KUN

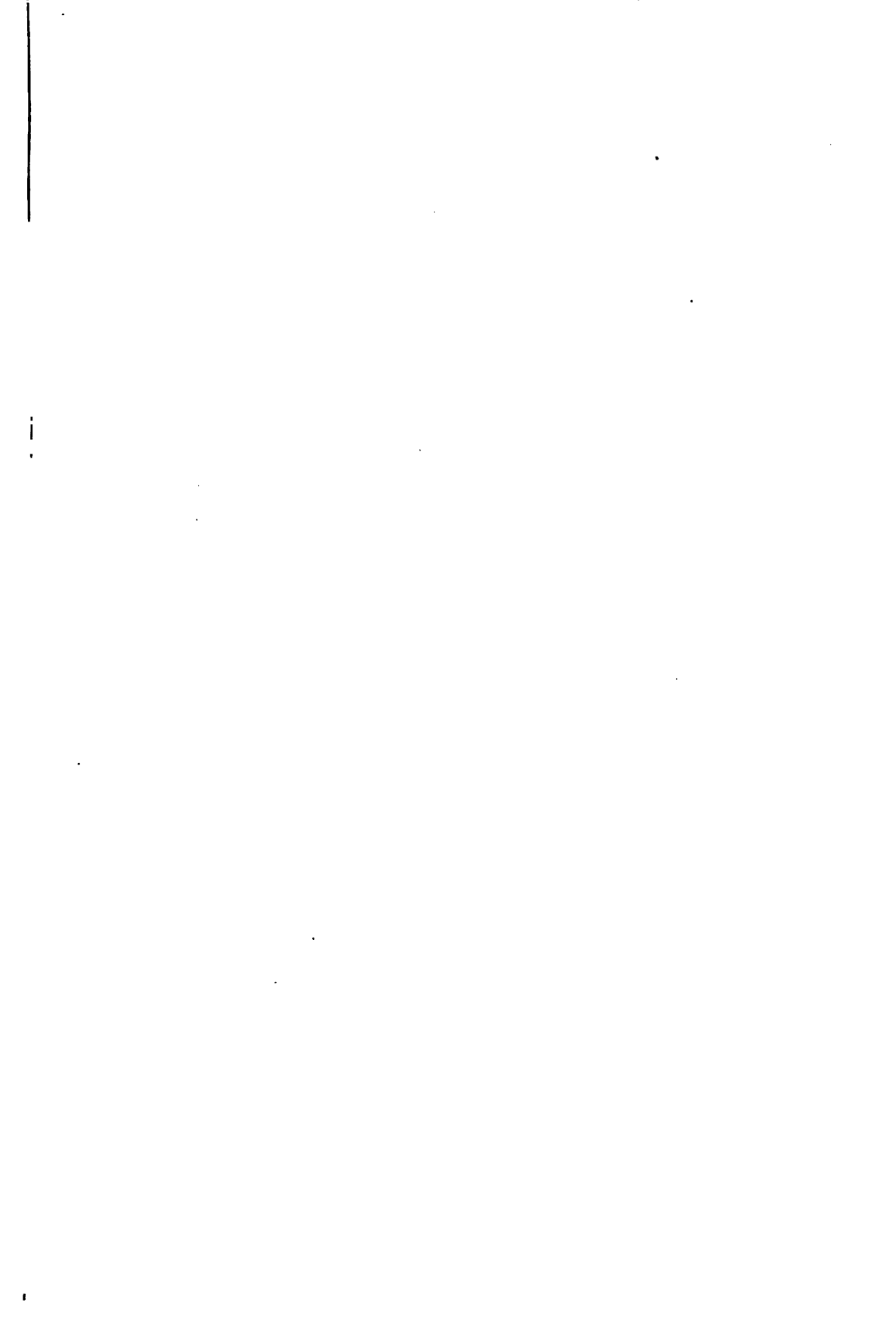
icicles, looked as if they had fought a hard battle with the elements. It was not strange they appeared half frozen after their march before dawn in a temperature below zero. People think they are enduring a good deal, when they start out from a warmed hut into the cold to make a winter ascent in the Alps, though they have slept at a low altitude in a reasonably warm place. They would find it a more difficult matter, after passing the night in an unwarmed tent on snow, to get up in a temperature below zero, collect their things, boil their coffee over a primus stove so affected by rarefied air that it will not light in five times the ordinary time, and, last but not easiest, wrestle with frozen boots. All this is in the programme of him or her who would climb a high Himalayan peak.

The necessary preparations having been made, the five of us roped and started upward. After three sleepless nights we did not feel any too fit, but as *l'appetit vient en mangeant*, so strength came with climbing, our muscles responding to the stimulus of exercise and our energies to that of the warming rays of the sun, when they at last fell upon us. Perhaps the use of granular kola, a French











preparation, may also have had a tonic effect. This in proper doses seems to be a good pick-me-up in cases of fatigue or where a continued physical strain must be undergone. If, however, taken in too large quantity, it produces giddiness and a feeling of lassitude, like other substances containing alkaloids similar to its own.

For an hour and a half we ascended a sharp incline broken by dangerous ice-falls and gashed by gruesome crevasses. Savoye led, cutting steps rapidly and skilfully. It was then suggested a bit of breakfast would be in order, so shelves were cut in the hardened snow of the slant, which was so steep that we otherwise could not sit to rest. We indulged in tinned tongue, which we have found a convenient, concentrated, and easily digested food at high altitude, varied by biscuit and plasmon chocolate. Our thirst was relieved by weak tea and coffee, which are far more serviceable in such work than any form of alcoholic beverages.

We then continued the ascent. The incline grew no easier as we ascended, rising continuously at angles of 60° to 65°. The snow covering the ice of the slope remained hard the whole forenoon,

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and almost every step in our upward progress had to be cut. In this respect this ascent was different from those made in Baltistan, where soft snow was found to be a great obstacle to high climbing. This difference was undoubtedly due to the constant succession of snow-storms we encountered in Baltistan, while here no new snow had fallen for weeks. After two and a half hours of constant step-cutting, which at that altitude must have been very fatiguing, Savoye exchanged places with the porter next him, who continued the work. We moved steadily upward, only stopping as the exigencies of step-cutting required, until a point on the skyline-arête running to the top of the peak was reached, at an altitude of 22,720 feet, commanding an extensive view. The sky was no longer clear. Clouds, which almost daily shrouded the mountain-tops towards noon, were rising. As it was desirable to photograph certain features of the landscape before they should be obscured, Dr Workman decided to stop here with one porter for this purpose.

Fortified by a light lunch of tea and plasmon chocolate Mrs Bullock Workman, with Savoye and





one porter, continued the ascent up the arête over rock and snow. But rock predominated, and the difficulty of breathing increased with every step, which, in connection with the rock-work, made this mountain particularly arduous to ascend. All who have been with us in Himalaya have agreed that climbing on rock is more exhausting at high altitudes than on snow. This, certainly, proved true in this present case, where several stiff places had to be overcome requiring strength, endurance, and breathing power. Here even Savoye, who has usually shown himself resistant to altitude effects, was glad to stop to breathe as often as the other two. Steady, though slow, progress was made, the task was at last accomplished, and the party stood at 23,300 feet.

The formation of this peak is peculiar. Seen from the plateau on which the last two camps stood, it slants upward to its apex in a broad surface covered with an ice-sheet, broken at its lower part into ice-falls. Its opposite or north-east face breaks down in almost perpendicular precipices. These two faces meet at the skyline in a sharp rock-arête projecting above the snow as a narrow rock-border over the whole summit, kept bare of snow by the



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high winds which sweep the region. The peak is so narrow between these two faces that, when seen in profile from points outside the massif to the north-west or from the ice-fall beneath Z1, it appears to be a very pointed aiguille too sharp to be climbable.

The view from here was essentially a bird's-eye view. Everything, except the highest Nun Kun, now cloud-bound, was overlooked. Beneath was spread out a wide galaxy of mountains running in snaky lines surmounted by winding crests, equally tortuous glaciers, and ribbon-like valleys wrapped in a vast chaos. Far to the north, towering high above all other peaks, Nanga Parbat raised its ice-clad head, which was soon hidden in cloud. The Eastern Karakoram, doubtless visible on a clear day, was concealed by rolling mists. Directly beneath, on the west, the sharp ice-slant we had ascended plunged down to the Nun Kun basin covered with a sheet of driven snow, while, on the east, a perpendicular precipice fell from where we stood some thousands of feet to a savage, rock-bound abyss containing the lower west branch of the Shafat glacier. The panorama from this pin-





nacle, while of great interest, was not so imposing as those from our highest summits in Baltistan ; for here everything was dwarfed and flattened, while there still higher mountains loomed around us, adding greatly to the effect of the distant views. The scarcity of oxygen was painfully felt on making any exertion with camera or instruments. An icy wind and the lateness of the hour precluded a long stay at this high vantage-point. It was after two o'clock, and camp could not be reached, at best, till nightfall, so the descent was begun.

After a careful study of the central peaks of the massif from points without it and from the high plateau, this peak was judged by all members of the expedition to be the second-highest of the group. Calculation from the reading of the boiling-point thermometer, compared with a simultaneous reading at the lower station of Dras, gives its altitude as 23,253 feet. On levelling off from a point just below the top on the peak next west, fixed by the Indian Survey at 23,264 feet, the latter peak appeared to be somewhat lower, seemingly about 50 feet. Hence the height of Pinnacle Peak has been placed at 23,300 feet.

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It may be said that this peak has been measured by a single vertical angle, and its height placed thereby at 22,810 feet. This at best can only be considered an approximate height, as surveyors universally admit that no measurement of a high peak by one angle only can be considered reliable. Colonel Burrard in his recent work, *The High Peaks of Asia*, part 1, p. 23, says, 'A single intersection of a peak from a single station deserves no weight whatever: it may give a result hundreds of feet in error.'

By this ascent Mrs Bullock Workman not only broke her last record-ascent for women of 22,568 feet, but won a place with Dr Workman in the small band of mountaineers who have reached a height of over 23,000 feet. On the way down the party ascended a projecting rock-needle at somewhat over 23,000 feet, where Dr Workman photographed them. The united party continued the descent. This was rendered dangerous by the now softened snow, through which our feet sank to hard ice, and great caution was necessary with every step. There was also danger from avalanches, which is always present on afternoon-descents of





sharp inclines. Camp was reached at 7 P.M. During the day the other porters brought up a tent, which was occupied by the guide and two porters who had accompanied us. They confessed the next morning to having passed a cold and sleepless night, as was also our experience. The temperature fell that night to  $-6^{\circ}$  Fahr.

After the fourth sleepless night, soon after sunrise on the morning of 30th July, the remaining porters, with the exception of the one who was ill, arrived from Camp Italia. Camp having been struck and loads shouldered, we all descended to Camp Italia, reaching it at 10.30 A.M. Here, sitting on our packs on the sunlit plateau, now about to be abandoned once more to the reign of the elements, we had an *al fresco* breakfast of biscuit, tinned meat, and hot coffee. Thus refreshed, we continued up to the brow of the basin and descended the steep slope leading to White Needle Camp. The noonday sun shone hot upon it, and transformed the snow covering its ice into a soft and dangerous mass, into which our feet sank deep and slipped at almost every step. The slope was in just the condition for an avalanche to occur. The descent was there-

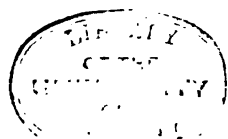


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fore not only more disagreeable, but more dangerous than the ascent, and we breathed more freely when it lay behind us and the camp was reached at half-past one o'clock. Two unloaded porters were immediately despatched to Nieve Penitente Camp, and the remaining seven of us prepared our quarters here for the night. The porters found the tent-servant, and sent him down to Base Camp for coolies. He arrived after sunset, and the next morning at three o'clock started back with forty of the strongest coolies by moonlight. Not being loaded, they marched without complaint and with good speed up the nearly 5000 feet of ice-slopes, reaching us by 10 A.M.

The night at White Needle Camp was boisterous and cold. The thermometer indicated 10° Fahr. No one slept. The place, although grand as an observation point, was not an agreeable one for a camp, and we were not sorry to leave it immediately on the arrival of the coolies, and to descend once more to grass for a few days' rest after the strenuous and exciting week in the icy fastnesses of the upper Nun Kun. As may be imagined, after the last five sleepless nights we were tired, and, on sitting down





for a few minutes, quickly fell asleep. A day or two at Base Camp was required to get our breathing apparatus into a normal 15,000 foot condition, but our appetite for roast mutton and chicken needed no coaxing after the meagre light-dietary necessitated by the higher environment. The adjustment period was of short duration. On the second day we were at work on the glacier below, and by the third day all were as fit as possible and ready to undertake further exploration.

## CHAPTER VI

Altitude-Effects—Mountain-sickness—Headache, Cough—Difficulty of Respiration—Insomnia—Cold—Mental and Physical Lassitude—Topography of Nun Kun Plateau—Three Glaciers fed by it.

LET us now consider some of the subjective experiences of the nine Europeans composing our party at the three highest camps at 19,900, 20,632, and 21,300 feet (by Airy's table 20,251, 21,093, and 21,600 feet).

Only one—the porter previously mentioned—suffered from mountain-sickness. Although, as stated, complaining of headache, weakness, and loss of appetite at Camp Italia, he started to go to Camp America with a light load of instruments, but was unable to keep up with the rest of us, and soon fell behind, showing unmistakable signs of mountain-sickness. Before reaching an altitude of 21,000 feet, though naturally a strong and healthy man, he collapsed entirely and became helpless. He said he had no sensation in his hands. His

woollen mittens being drawn off, his fingers were found white and stiff, and, if not already frostbitten, on the point of becoming so. Vigorous rubbing and pounding finally restored circulation, and he was then sent down to Camp Italia. The fact that his hands, even when protected by thick woollen mittens, were brought by the cold to the verge of frostbite, while the hands of Dr Workman, who was using a camera, were comfortably warm without any covering, shows how profoundly the circulation and vitality are prostrated by mountain-sickness, and how dangerous it is for one suffering from this malady to be exposed to the cold of high altitudes.

At White Needle Camp, 19,900 feet, three of the party were affected with headache and pain in back and limbs, more pronounced at night, which increased with greater altitude and ceased only on return to lower levels. A fourth had headache at night. At White Needle Camp and above, three were troubled with cough without bronchitis or pharyngitis, which disappeared in two cases on return to Base Camp, but persisted for a week in the third. These symptoms did not, however, incapacitate any one

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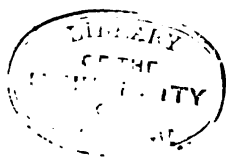
from accomplishing the daily work, with the exception of the porter who was ill.

Every one, as was to be expected, felt the effect of altitude on the respiration, though some to a greater extent than others. This, as usual, manifested itself by shortness of breath and panting on slight exertion. In the erect position, when resting, the respiratory disturbance was not so noticeable, being marked only on movement; but at night on lying down it became more urgent, being accompanied by a feeling of oppression, for the relief of which a number of deep inspirations were necessary. The frequent repetition of these wearied the respiratory muscles and even became painful. This constant gasping for breath interfered with sleep, no matter how tired one might be; and if, at last, after a long period of prostrating wakefulness, one did doze for a moment, one would immediately start up with frantic efforts to obtain sufficient oxygen to relieve the stifling sensation that threatened to terminate one's existence.

During the five nights at our three highest camps no one obtained more than a few snatches of sleep, and four practically none at all. Those nights are







not easily forgotten, when one lay sleepless on the snow, in the cold, and silence, and darkness, struggling for breath, and counting the slowly dragging hours with a feeling that the strain could not be endured till daylight. It is scarcely necessary to say, that even the strongest could not hold out for long against the depressing influence of loss of sleep, combined with the lowering of vital energy due to scarcity of oxygen at these high altitudes. We were conscious of a distinct decline in strength on the last two days, and, after six consecutive days of hard work and five sleepless nights, every one felt an irresistible desire to relieve the tension by a descent to a lower level.

We have elsewhere, in connection with our highest camp in the Chogo Lungma region, at 19,358 feet, where five Europeans were affected in a similar manner during two nights, suggested the possibility that, in attempts on the highest Himalayan summits, where camps would have to be made at from 23,000 to, probably, over 27,000 feet, insomnia alone, irrespective of other obstacles, might prevent success (see *Ice-Bound Heights of the Mustagh*, p. 297). This corroborative experience of nine active mountaineers

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at camps approximately 550, 1300, and 2000 feet higher than that above mentioned, at all of which respiratory disturbance and insomnia were distinctly more pronounced, being most marked at the highest, appears to justify the opinion, that insomnia will be found an adverse factor in high mountain-work no less formidable than cold, deficiency of oxygen, and weather, and much more so than mountain-sickness, inasmuch as it appears likely to affect a larger number of climbers.

We found the low temperature  $-4^{\circ}$  and  $-6^{\circ}$  Fahr., and even of  $17^{\circ}$  and  $10^{\circ}$  with strong wind, trying at night. Arctic explorers endure temperatures much lower than these without difficulty, but their work lies near sea-level, where the atmospheric pressure is more than double that at 21,000 feet, and they can encase themselves in furs without suffering from their weight. There the air contains sufficient oxygen to enable them to breathe freely under any degree of exertion and to sleep soundly, thus sustaining the bodily heat and vital forces at a normal limit, so that they can offer a maximum power of resistance to cold. But at high altitudes, where vitality has been lowered by hard work, loss of sleep, and deficient





oxygenation, where only a closely calculated minimum of clothing and bedding can be carried, an amount really insufficient to protect one against cold, a temperature of zero means a good deal more than it does to the arctic explorer. The mountaineer at high altitudes is called on to endure arctic conditions without the means of protection available to the arctic explorer. All our party, in addition to flannel-lined Mummery tents, with ground-sheets sewn in, were provided with rubber ground-sheets and well-padded eider sleeping-sacks, enclosed in outer ones of camel-hair or army blankets; but these were inadequate to prevent us, even when wearing our thickest clothing besides, from feeling the cold sensibly at night at White Needle Camp, and to a much greater degree at the two highest camps. Two thousand feet higher, where the cold would be considerably greater, we should probably have suffered more severely.

Our primus stoves and hypsometer-lamps felt the altitude quite as much as we. The alcohol in the lighting cups of the former would not burn until the cups had been heated by the application of half a dozen burning matches, and the petroleum-gas

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issuing from the burners was only partially consumed when cooking-utensils were placed at the ordinary distance above the latter, the rest escaping in smoky, ill-smelling fumes. To ensure complete combustion, it was necessary to give the flame its full height, so that the air could have access to it from every point. With this precaution petroleum in a primus stove makes a more efficient fuel, and generates a much greater heat at high altitudes than alcohol used in any apparatus we have seen. The wicks of the hypsometer-lamps were also lighted with difficulty, three or more matches in succession being required, and when they were lighted, placing the lamps in the metal-jackets promptly extinguished the flame. Having had the same experience previously, we had had the burning-tubes replaced by new ones of double the diameter, but this did not help the matter. The ordinary jacket does not admit sufficient oxygen to ensure combustion at high altitudes. The lower half of the jacket, at least, should be made of wire-gauze so as to admit all the air possible.

The effect of altitude on the mind, which was noticeable here as it has been elsewhere above







## EFFECT OF ALTITUDE ON THE MIND 99

18,000 or 19,000 feet, deserves mention. Owing, perhaps, to a general loss of energy and to the disturbance of respiration and circulation incident to even moderate exertion, a mental condition of irresolution and disinclination to effort supervenes. The simplest actions assume formidable proportions, and even photography and the taking of readings, which one recognises as of great importance and which at ordinary altitudes are not difficult processes, become bugbears; while the ascent of a peak, a really arduous undertaking at high altitudes, looms up as an almost impossible proposition. One has, therefore, often to call the will into play to its utmost power to force oneself to carry out what has been proposed. Those who are destined to raise the mountaineering altitude-record much higher than it now stands will undoubtedly be persons of strong will and self-control.

Another point of interest is, that the guide and porters were able to carry loads of thirty-five to forty pounds to an altitude of 21,300 feet. The gradients, except that of the ice-wall above White Needle Camp, were not steep, and the last two marches upward were only about three hours;

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but to carry loads of forty pounds up inclines of  $25^{\circ}$  to  $35^{\circ}$  in snow ankle-deep at that altitude requires strength and endurance. How much higher they could have gone, or up how much sharper slopes, we will not venture an opinion. Savoye expressed grave doubts, whether they could carry the same loads up much steeper gradients than were encountered, for at altitudes like these the difficulty of carrying a given load increases enormously with a comparatively slight increase in the gradient. How many feet in altitude above 21,000 loaded porters can ascend in a day remains yet to be shown. Granting that no other obstacle than altitude and gradient exist, it is evident that the vertical distance in a given case would depend on the gradient. The steeper this is the less the distance that could be accomplished. Also, the gradient remaining the same, increasing altitude would put a check on the distance covered. With the present available knowledge, it appears likely that each succeeding march above 21,000 feet would be less than the preceding one. Judging from our own experience, we should consider a march of 2000 vertical feet above 21,000, for loaded men, even with favourable gradients, an

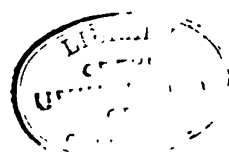
exceptional accomplishment. Probably one of 1000 feet would be nearer what would be possible, and, were soft snow present or much step-cutting required, the possible distance would fall considerably short of this.

The question, to what absolute height trained mountaineers will be able to carry outfit requisite to camping must be left for the future to decide. With the various obstacles to high climbing more accentuated in proportion to altitude, it seems certain that loads will have to be reduced as altitude increases, until a limit will at last be reached, where not enough can be carried to support life and protect the mountaineer against cold and weather. That limit may be found to be considerably below heights at which camps will have to be made to render the highest summits accessible.

One of the most interesting features of the Nun Kun is the plateau or snow-basin where we camped, which, enclosed by its circlet of seven glittering peaks, sits like a diadem on the brow of the lofty massif which it crowns. Its surface is undulating, being depressed in the centre but rising towards the bases of the peaks, where it shades off into the

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mountain-slopes. The altitude of its highest portion, which is at the north-east end beneath the second-highest peak, is 21,600 feet. Thence it slopes away to the south-west to about 20,300 feet at the Ganri outlet under the highest peak. Its shape is oblong, its long diameter, running north-east and south-west, being three and a half miles, and its conjugate diameter about a mile and a half. The peaks rise sharply from it, and descend more sharply, largely in perpendicular precipices, on the outer side. The four north-east peaks are connected by rock and snow-saddles. The other three, including the highest at the south-west end, stand alone, rising directly from the ice of the plateau. Around the bases of these three the basin has four outlets, by which its snows escape to form the ultimate source of the three principal glaciers of the massif, one stream descending north-west between the highest peak and the one next north, *i.e.* between the peaks known as Ser and Mer, to make one head of the Ganri glacier, two others to the south to feed the short but broad Faribad glacier, and the fourth also to the south, to contribute to the north reservoir of the Shafat glacier. This last, owing to the con-



## 104 PEAKS AND GLACIERS OF NUN KUN

one seldom seen in purely mountain-glaciers, is its tongue, which ends abruptly at the river-bank, like that of a polar glacier extending to tide-water, in a perpendicular ice-precipice about 600 feet long and 200 high. Its successive layers, as they separate themselves, break off along cleavages transverse to its axis corresponding to closed crevasses, and fall in miniature icebergs into the current, by which they are carried away and strewn along the river-banks below. The river washes the base of the whole front of the tongue, apparently cutting under its lower edge somewhat; but the depth to which it can undermine the ice must be slight, as the latter does not project appreciably into the river, but breaks off at the edge of the bank. Here a river not many feet in depth is seen to produce the same effect upon a massive glacial tongue as is produced by the deeper waters of the polar oceans upon the glacial tongues that push into them.

West of the tongue, and separated from it by a considerable interval, a giant lateral moraine, estimated to be over 200 feet high, and towering above it by more than 100 feet, extends entirely across the valley, and similarly a shorter lateral moraine







projects on its east side. These moraines, together with the boulder-masses piled up in the space between them, show that the glacier was formerly much longer, wider, and thicker, than at present, covering the whole width of the valley and impinging against the opposite mountain-walls. The amount of detritus brought down to build these moraines and boulder-masses was enormous. At present the glacier, as seen both from above and below, appears remarkably clean and free from detritus.

The third or Fariabad glacier, beginning in the two southern outlets of the basin above mentioned, and reinforced by snows from the external slopes of the two western peaks, descends rapidly in a confused mass of ice-falls, caverns, crevasses, and séracs, directly south to the side of the Z1 glacier above the opening of the Fariabad nala. It is separated from the Shafat glacier on the east by the ridge before mentioned, and is bounded on the west by a large spur from the highest Nun Kun descending to the Fariabad opening. Its length is four and its width two miles. It is a most dangerous glacier to venture on.

The three principal Nun Kun glaciers are not very

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long, being respectively only nine, eight, and four, miles in length, but, springing from heights of from 22,000 to over 23,000 feet, and falling 10,000 to 11,000 feet in these short distances, they possess great potential energy, developing ice-falls, ice-precipices, and séracs, as large and high, crevasses and abysses as wide and profound, ridges and ravines as pronounced, and moraines as gigantic, as those found on glaciers of far greater size and length.

Of the seven high peaks enclosing the upper plateau, the two most conspicuous from the travelled routes and heights to the north and west, which have chiefly attracted the notice of those visiting the neighbouring region, are the highest, the Ser of the Survey rising at its south-west end, and the one next north of it, the Mer. They present broad surfaces towards the directions stated, and are less concealed by enclosing heights than their neighbours, all view of which from the west they cut off.

Pinnacle Peak at the north-east end, as already stated, appears from the north only as a slender needle projecting above a multitude of other spires, which does not attract the attention its altitude and size warrant. On the other hand, from the upper





part of the Rangdum valley to the east, toward which its broad face is turned, it appears to be the highest and most massive peak of the group, hiding from view all the other peaks, except the one next south on the same face connected with it by a col. The three remaining southern peaks are not visible from any direction except from the upper half of the Shafat glacier and the heights south of it.

No adequate conception of the conformation of the Nun Kun group can be obtained from points outside it. The manner in which it is laid down on the Survey map is an evidence of this, and shows the difficulty the Survey observers had, from something like a dozen outside stations in the vicinity, in distinguishing among its jumble of members even its salient external features, more or less concealed by outlying buttresses. One must penetrate it at different points, and explore its recesses at different altitudes, to be able to form an adequate idea of its topography.

## CHAPTER VII

Reconnaissance preliminary to First Circuit of the Nun Kun—Final Departure from Base Camp—Terminal Moraines—Banded Structure of Tongue of Z1 Glacier—Ascent of North-West Nala—North-West Col—Camp on Barmal La—Barmal Glacier and Barmal La—First Ascent of Mount Nieve Penitente.

DURING the three days of comparative rest at Base Camp we were by no means idle. Besides finishing some observations on the glacier, we busied ourselves with preparations to execute a plan, which had now assumed a definite shape in our minds. Not wishing to return to Suru by the Rangdum valley route, unless obliged to do so, we determined to try to find a passage around the range by the south and west, and thus complete for the first time the circuit of it, which had never before been attempted. To do this would be a matter of pure pioneering, as the coolies knew nothing of the uninhabited and partly unexplored region that would have to be traversed, and no assistance could be







## RECONNAISSANCE AT HEAD OF SHAFAT 109

obtained from the Survey map, which gives no idea of its topography.

Before definitely starting to carry out our purpose, we concluded to make another reconnaissance above the head of the Shafat glacier. On the morning of 5th August, with Savoye, two porters, one servant, and sixteen coolies, taking only light tents, we ascended the Shafat glacier for the third time to the Fariabad Col, where we camped about 50 feet below its top at 16,860 feet. While the coolies were preparing tent-terraces among the rocks under the direction of the servant, we pushed westward over the Fariabad glacier to see if any passage existed in that direction, but, on reaching a point directly south of the highest Nun Kun peak, we were stopped by numberless large crevasses running in all directions, which rendered further progress impossible. We therefore returned to the col, where tents were pitched on the terraces, which had been made. The minimum temperature that night was 26° Fahr.

Early next morning we descended the Fariabad glacier, which was here smooth, for a short distance to a rock-spur of Z1. Getting on this we ascended over narrow shaly ledges, working around its side

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to the south, until we reached an angle at an altitude of somewhat over 17,000 feet, which commanded a view of the surrounding region. From here we saw that, had we not been stopped the afternoon before by the crevasses, we should have been brought up by a great rock-spur, here seen for the first time, descending from the highest Nun Kun to the Fariabad opening. Some distance to the south-west, about 4000 feet below, the Fariabad nala opened, clothed with green vegetation. Leading down to it on our left ran another nala from the Z1 massif, occupied, as far as we could see, by a steep ice-fall ending in a glacier.

From the Fariabad opening another nala was seen running five or six miles north-west to a snowy cirque, at the top of which a saddle might be found. The Fariabad glacier in front of us dropped down greatly broken and very steep to the Z1 nala. After careful observation of the topographical features of the region, we concluded that, if a caravan could be got down from the Fariabad Col to the nala below, we should be able to work our way up the nala leading north-west and over the snowy heights in the distance and find a route to Tongul, the nearest





## PREPARATIONS TO LEAVE BASE CAMP 111

village in the Suru valley, and so complete the circuit of the Nun Kun. The question which we could not solve with certainty was that of the descent, as the rocks and ice-walls fell away so steeply that they were not visible for any great distance from where we stood. However, as we had great confidence in Savoye's experience and skill in finding a way over difficult places, we decided to risk the attempt.

Returning to camp, we sent down the coolies with all our baggage to Base Camp, while we ascended over the head of the Shafat glacier to the rock-promontory above the site of Camp Nieve Penitente. Upon the top of this a stone-cairn was built, in which records were deposited. We then returned to Base Camp, which was reached at 3 P.M. The next two days were busy days. Not only had we to make preparations for the march through the unknown region before us, but also for the final breaking up of Base Camp and the transport back to Suru of all superfluous luggage and supplies. We judged nine days would be sufficient to complete the circuit, and, as we were to burn our bridges behind us, the amount of provisions required for that time must

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be calculated and taken. There were but fifty coolies available for the work. Of these fifteen were required to transport coolie-food and five to carry wood, leaving only thirty to take the tents, clothing, and provisions, of nine Europeans and two native servants. Our kit had therefore to be reduced to the lowest limit and arranged with care and exactitude.

A coolie was despatched to Mr Hogg at Suru to send fifty coolies immediately to Base Camp to take back to Suru everything we left behind, a substantial stone-cairn was built on the highest point of the camp-site, in which records were left, and on the morning of 9th August, leaving the Gurkha, shikari, and one tent-servant, to look after the baggage and supplies, together with the cheerful cock and one hen, which were to be taken also to Suru, and a coolie in charge of the fifteen goats and several sheep, we took leave of Base Camp and started forth up the glacier with fifty coolies.

As the caravan filed out, the cock flew up on a rock and gave us a hearty send-off in a series of shrill crows. The condition of the glacier was found greatly changed since we had first ascended it three





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them. These four sheep opposed with equal obstinacy all efforts to drive or lead them. We had only gone about two miles, when one of them fell into a crevasse and was seen no more. Shortly afterwards another escaped, and ran away over the glacier so fast that the agility neither of porters nor coolies was equal to capturing it, so, as a long march lay before us and there was no time to waste in pursuing it, it was left to its fate. Whether it ever got down again to grass we did not learn.

The caravan reached the Fariabad Col by twelve o'clock. From this the edge of the Fariabad glacier was descended for twenty minutes, when the glacier became so steep and broken that it could no longer be followed. We left it, therefore, at an altitude of about 16,000 feet for the rock-spur of Z1, which falls away precipitous and in places almost perpendicular some 2000 feet to the Z1 glacier in the Z1 nala. The face of this spur is greatly shattered and covered with loose rocks and débris, which with its abruptness makes it dangerous to negotiate, but it was doubly so for those leading the way, with a train of coolies behind. We went ahead with Savoye and three porters, taking good care to keep out of reach





of the falling stones the shuffling coolies sent down in repeated avalanches. Three porters remained with the coolies to direct their movements, and the latter were stopped several times, till we had passed couloirs, where they might dislodge stones upon us. This spur runs down between a magnificent ice-fall descending from the upper part of Z1 into the nala and the broad front of the Fariabad glacier, which we had on our left and right hand respectively. In two hours and a half the base of the spur was reached, and, after a rough scramble over boulders, we got upon the glacier, which, as a prolongation of the Z1 ice-fall, fills the Z1 nala to within half a mile of the opening into it of the Fariabad nala.

The Fariabad glacier, coming down very abruptly for some 2500 feet in a broad and greatly crevassed wall, remarkably free from rock-débris, ends suddenly at the edge of the Z1 glacier without joining it and without any terminal moraine, forming a part of the wall of the Z1 nala. A short distance farther down the nala the tongue of the Z1 glacier ends in a steeply slanting front of discoloured ice, 300 feet or more in height, with a sharply defined, curving contour thickly seamed with longitudinal

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crevasses. It also has no terminal moraine, though the nala-bed below it is sprinkled quite thickly with small boulders and débris.

Glaciers do not by any means always form terminal moraines. As to this fact there is no difference of opinion among glaciologists, however they may account for the formation of such moraines. The one hypothesis, that terminal moraines result from the gathering up and pushing along of the sub-glacial ground-moraine material, and even, as some hold, of the ploughing up of the terrain beneath the ground-moraine by an advancing tongue, and to a less extent by a stationary one, so as to form a wall at its end, fails to account for the cases where no terminal moraine results even under the most favourable conditions of active advance. It also ignores or minimises the part which moraine-material carried by a tongue must play in the process of moraine-building. It is evident that no moraine would be formed by a tongue in retreat.

The other hypothesis, that such moraines are wholly due to the deposition and excretion of the material lying in and upon the tongue, presupposes the co-operation of two factors: (1) that a glacial





## TERMINAL MORaine HYPOTHESES 117

tongue should carry a considerable quantity of detritus, and (2) that its front should remain stationary long enough for the detritus to be deposited in sufficient quantity to form a moraine, the ice from above advancing to the terminal line as fast as the ice there melts, and discharging its detritus upon that already deposited, till the process is completed. By this hypothesis, if a tongue carries no moraine-material, no moraine should be formed under any conditions of advance or retreat. This fails, in its turn, to account for those cases where glacial tongues bearing no observable moraine-material have been found bounded by high and large terminal moraines. If the end of a tongue recedes faster than the ice above it advances, no moraine can result, the detritus being spread more or less evenly over the denuded surface without accumulating at any one point.

The tongues of the two above-mentioned glaciers, at present, furnish examples of the absence of one of these factors in each case. The Fariabad tongue bears no detritus to speak of, and has no deposit at its end. That of Z1 has been receding constantly and rather rapidly for some time, and, though

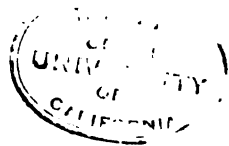


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carrying considerable débris, has left it evenly distributed over the nala-bed in front of it, not having paused long enough at any one point to build an elevation that might be called a moraine. Half a mile farther down the nala are some larger débris deposits overgrown with vegetation, which might be regarded as terminal moraines.

The successive terminal moraines often found in front of glaciers, with intervals between them little or not at all strewn with detritus, show that the same glacier, according to the presence of both these factors or to the absence of one or both, or, according to the first hypothesis, during successive advances after periods of retreat, may build terminal moraines at one time and fail to do so at another. The smoothness of many such intervals would indicate that, during a period of recession, the respective tongue carried little or no detritus. In Himalaya, glaciers may recede for considerable distances without leaving behind débris of any size, as in case of the Chogo Lungma tongue (see the *Geographical Journal*, March 1905, p. 251, and *Ice-Bound Heights of the Mustagh*, p. 172), which retreated 1184 feet in forty-two years, leaving a smooth river-bed below





it. Observed facts appear to show that there is truth in both the above hypotheses, and it is not improbable that many moraines are formed by the combined action of both the methods they suggest. In 1902 and 1903, when we examined the tongue of the Tippur glacier, near that of the Chogo Lungma, it was adding to its large terminal moraine at a rapid rate by the deposit upon the latter of detritus from its upper surface.

The rounded extremity of the Z1 glacier, though greatly discoloured and seamed with perpendicular, longitudinal crevasses, affords a fine example of banded structure, the bands running in parallel, symmetrical, horizontal lines around its terminal contour. This symmetrical arrangement of the bands is the more remarkable, inasmuch as the glacier for the greater part of its course falls very sharply and is broken into an uninterrupted series of séracked ice-falls. It would seem almost impossible that the bands composing its structure, formed by the folding of the névé-strata by the lateral pressure due to the narrowing of its bed, after descending for several thousand feet through the tumbled chaos of its ice-falls, could assume at the tongue such a typical

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and regular arrangement. The horizontal position of the bands, as well as the open perpendicular crevasses, may be ascribed to the fact that the extremity of the tongue, being relieved from lateral pressure, spreads somewhat.

Shortly below the tongue of the Z1 glacier the nala became covered with vegetation, and, after a half-hour's march, we reached, at five o'clock, a large grass-covered maidan at the meeting-point of the Z1 nala, Fariabad nala running south, and North-West Nala, so named by us, leading north-west. Near the junction of two streams coming from the Z1 nala and North-West nala we camped at 13,480 feet (Fariabad Camp). When the coolies came to our tents that evening begging for 'tambacco,' we gave it to them willingly, for they had placed no obstacle in the way of carrying out this first passage through an unknown glacial region, but had followed us without a murmur, making a long, fatiguing, and rather perilous march for a loaded caravan, climbing from 15,100 to 17,000 feet up a crevassed glacier, and descending over the face of a dangerous rock-wall and a glacier to 13,480 feet, a good day's work.





## SAND-MORaine IN NORTH-WEST NALA 121

The next morning we were up at five o'clock prepared for an early start. The weather was threatening. Heavy clouds enveloped the mountains and hung low in the valley, and rain was falling. We waited a while before striking tents, as it did not seem advisable to venture up an unknown nala in a storm. Shortly after seven a wind sprang up, which drove the clouds apart. This gave promise of improvement, so the last articles were packed and we started up the North-West nala. About a mile above the camp, west of the rock-spur from the highest Nun Kun, a glacier coming from the base of that peak reached the nala in an ice-fall on its north side but did not penetrate it. Two miles above this a glacier descending from mountains on the south side filled the nala for another mile. Two hundred feet in front of its tongue was a high terminal moraine composed entirely of fine brown sand with ice still beneath it. The sand had protected the ice on which it rested from the sun's heat, while the uncovered ice behind it had melted entirely away. The facts, that the sand-moraine rested on glacier-ice, that no sand formation existed on the heights above from which



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the moraine-sand could have been derived, and that no sand was found on the glacier above, warrant the assumption that this moraine was formed by the ploughing up of the nala-bed by the tongue of the glacier during an advance.

We ascended this glacier, which was considerably crevassed, for half a mile, and then climbed several hundred feet and followed the side of a rough but vegetation-covered mountain-slope for some distance. At one o'clock a small, uneven terrace clothed with grass was reached, the last place in the nala suitable for a camp. Here, at an altitude of 14,600 feet, we camped (Hillside Camp). This camp commanded a view of the upper part of the nala, which above this point becomes wilder and is destitute of vegetation. A mile higher up it ends in a large amphitheatre of snow and ice, the ridge enclosing which begins at Mount Nieve Penitente, three miles west by south of the highest Nun Kun, and runs around south and south-east, rising into several summits, to a snow-peak above the Fariabad opening. This amphitheatre drains into the North-West nala, and sends down a glacier into its head, another already mentioned into it below Hillside Camp, and





the tongue of a third immediately opposite and beneath the camp. On this last tongue there were two picturesque surface-lakes.

The next day there was plenty of scrambling over ragged surfaces strewn with boulders and cleft by glacial torrents, before the firm, white ice leading up the face of the amphitheatre was reached. We kept near its northern edge, and at noon came to the top, a snow-col surrounded on all sides by ice-fields at an altitude of 17,397 feet. This we named North-West Col. It lies directly south of Mount Nieve Penitente about a mile from it and east of the head of the Bara Zaj Nai, to which most dangerous-looking ice-slopes descend. The prismatic compass was set up, and bearings taken for the further route. Examining the peaks and ridges to the north, we discovered a col or short arête connecting Mount Nieve Penitente with another lower rock-peak west of it. This lay N. 38° W. of North-West Col, and we afterwards found that a straight line from here to the col now seen, when prolonged, passed through the Sentik La, later to be mentioned. This was evidently the point for which we should steer.

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A gentle descent of half an hour brought us to rocks at the base of the peak, which we named Mount Nieve Penitente for a reason which will appear later on. Here we ate our luncheon and waited for the coolies. About one o'clock they were seen struggling up to the col, where they stopped to rest and eat. A dense fog now set in, shutting out all landmarks. This did not delay us to any extent, however. As our bearings had been carefully taken, and as we knew the porters with the coolies would follow our tracks, we continued on in the fog up a snow-slope between an ice-fall and a bergschrund, and at two o'clock found ourselves, as the mist lifted, close under the perpendicular face of a rock-peak adjoining the rock-col we were aiming for. We ascended to the top of the col, and found it to be a narrow tortuous ridge, rising from the snow, connecting the sharp rock-peak just mentioned with Mount Nieve Penitente lying east of it. It afforded the only camping-place, not on ice, in the vicinity, and although it might, from its exposed position, prove a most disagreeable trough, if wind or storm should come up, we determined to utilise it for this purpose. There was not a level spot on it. Its





surface was covered with heaps of stones, slabs, and boulders, mingled with some earthy *débris*; and where these ended an ice-wall began, which descended in a very steep slant several hundred feet to a glacier below.

It is interesting to see out of what different kinds of terrain tent-terraces can be constructed, especially when five or six resolute men set to work with ice-axes. While the surrounding peaks were being veiled and unveiled by the moving clouds, the whole party worked with a will, lifting, placing, splitting, and pounding off, rocks and digging out the finer *débris* with which to fill the interstices. By four o'clock, when the coolies came up, two passable stone terraces were ready for tents. The coolie-caravan was headed by the Kashmiri khansamah, who had swindled us for five seasons, looking tired and out of temper. 'Have a place made for your tent,' we called to him, 'for we expect to stay here two days.' 'Two days here?' he exclaimed in a rage, his face presenting a droll study. But he knew we meant it, and he soon returned to help place the tents. As it happened, we remained four nights and three days. In another hour camp was estab-



## 126 PEAKS AND GLACIERS OF NUN KUN

lished, and all had settled down to making themselves at home in their various quarters. Part of the coolies set up their two tents, but others preferred to build themselves huts with the rocks and slabs which covered the ridge.

Up to this point the coolies had not been able to tell us anything of the region we had traversed, but here several of them recognised the surroundings, and said we were on the Barmal La. We therefore called the camp Barmal Camp. Its altitude was 17,260 feet. The situation of the Barmal La is wild and grand in the extreme, lying, as it does, in a narrow gap between two mountains towering directly above it, with nothing but ice, snow, and rock, visible in any direction. The peak enclosing it on the southwest, rising a thousand feet in an absolutely perpendicular precipice, terminates in two rock-needles, while that on its east is the impressive, hitherto unnamed mountain which we called Mount Nieve Penitente. Between these mountains to the southeast a good view is obtained of the North-West Col, the snow-ridge leading from it around towards the Fariabad opening, the broken ice-slants falling from it into the head of the Bara Zaj Nai nala, and of





Zaskar peaks beyond. From Mount Nieve Penitente a high, curved, rock and snow-wall, named by us the Barmal Ridge, runs north for two miles to another higher mountain, D41 of the Indian Survey.

The Barmal glacier, a beautiful sheet of ice springing from the slopes of the last two mountains and from the Barmal Ridge, passes directly beneath the Barmal La, and sweeps westward for some eight miles, walled in on each side by a line of jagged peaks, and appears to end among green slopes south of a mountain-cirque enclosing the reservoir of a branch of the Bhot Kol glacier. Indeed, from the configuration of the mountains at this point, as seen from Mount Nieve Penitente and from the Bhot Kol, the glacier must end as stated or push somewhat farther in a south-westerly direction towards the Bara Zaj Nai, or possibly the Chota Zaj Nai, as it is enclosed on the north and west by the peaks and ridges south and south-east of the Bhot Kol.

The indications are that it drains into the Bara Zaj Nai. From the summit of Mount Nieve Penitente, not only the course of the Barmal glacier, but also that of the Bara Zaj Nai can be seen for a long

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distance. The mountain-ridge separating the two, after running west for some miles, towards the end of the Barmal glacier turns south-west, and appears to narrow almost to a point, so that the two approach each other. The actual determination of the drainage of the Barmal glacier will be the task of the future explorer, as no one has visited its lower end up to date. On our map we have represented the Barmal as draining into the Bara Zaj Nai, this being the only instance of any change from the Survey map of a feature that has not been actually observed.

The width of the Barmal glacier near its origin is two miles, but it soon narrows to about one mile, which width it maintains for over five miles. This glacier has, evidently, been long known to the natives, who often cross its upper end with yaks in going between Tongul and the Bara Zaj Nai and also the Fariabad nala. Local tradition credits one European with having visited it many years ago. In 1902 Rev C. E. Barton and Dr A. Neve, ascending from Tongul, crossed it to the Bara Zaj Nai nala at a point about five miles west of the highest Nun Kun. In 1904 Dr Neve reports having crossed it again at





the same point and having climbed on the side of D41 to a height estimated at 19,200 feet.

The Barmal La stands, perhaps, 600 feet above the Barmal glacier, connected with it by a steep ice-wall cleft by two, wide bergschrunds. To ascend or descend this wall requires mountain-outfit and a good knowledge of ice-craft. Our coolies were powerless to negotiate it by themselves, and even the guide and porters would not venture on it unroped. Two rock-cairns stand on the summit of the la. By whom they were made we could not learn. No records were found in them, and we know of no account of any European having previously visited this place. As it is practically certain that natives could not reach it from the Barmal glacier, unless the ice-wall were greatly changed, it may be surmised that some party, having come up to it from the south side, mistaking it for a lower snow-pass somewhat further west, and having found the descent to the Barmal glacier barred by the ice-wall, built these cairns as a beacon, by which the place might in future be avoided. The existence of other cairns to the south indicating the way to the other pass supports this view. About three-quarters of



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a mile west lies the snow-pass referred to leading from the Barmal glacier to the Bara Zaj Nai and also to the North-West Col and nala, which is accessible on both sides by easy snow-slopes. It is over this pass that the natives take their yak-caravans from Tongul, and this was the pass used by Dr Neve, also under the name of the Barmal La.

On the route hither, as sufficient brushwood had been found at both camps for all needs, the coolies had been forbidden to use the five loads brought from the Shafat. Notwithstanding this, on arrival at Barmal Camp the loads had dwindled in size and, if used freely, would not last a day, and we were at over 17,500 feet, a good 5000 feet above the wood-line. The khansamah called up one of the most intelligent coolies, who said they could go down in one day into the Bara Zaj Nai, and the second day return with wood, so it was arranged that thirty coolies should start early the next morning for this purpose.

We had planned on that day to attempt the ascent of Mount Nieve Penitente, which from its position was sure to afford a fine view of the topographical features of the region, but it was an angry-





## COOLIES REFUSE TO GET WOOD 131

looking affair from this side, composed of sheer rock, overtopped by sheer snow-walls. Savoye said he would prefer to examine it and find the best route before we started, so with the prospect of wood being brought up by the coolies, which would enable us to remain longer than at first intended, we agreed to wait. Early in the morning he and two porters left to make a reconnaissance.

After their departure all the coolies came to our tents to announce that they would not go down for wood. We told them they would have no fires unless they went, that we should not hurry away on their account, and that they would have to endure the freezing nights as best they could, but they remained obdurate. As they received the same pay, whether working or lying idle, they took this occasion to prefer doing the latter. It is, however, possible that they would be unable unaided to get down the ice-slopes into the Bara Zaj Nai, and that a knowledge of this deterred them from going, although they did not urge this as an excuse. The remaining wood, of which there was only sufficient to last the Europeans for one day, was now divided between our khansamah and the porters,

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and the coolies got no more of it. On this journey they were using satu, or cooked corn-meal, mixed with water, so they could get along without fires, but we missed the latter sorely, and were obliged after the second day to resort to high-mountain food prepared over primus stoves, an unnecessary deprivation below 18,000 feet.

The two sheep, which had survived glacial travel to this point, had to be killed at once, as there was nothing for them to eat, but the advantage of having fresh meat could not be fully utilised on account of the failure of the coolies to supply the camp with wood. For this latter reason five chickens, also brought along, had to be taken down to lower regions before being killed. They did not mind the altitude, and ran about actively in and out of the tents picking up rice and bits of biscuit, with which they were fed.

Savoye and the two porters on their return reported the mountain to be climbable, though the ice-slants above the rocks were very steep. We accordingly decided to attempt it the next day, if the weather proved favourable. The morning of 13th August broke clear and cold. At five o'clock, in a tempera-

## ASCENT OF MOUNT NIEVE PENITENTE 133

ture of 20° Fahr., we started from camp. Cutting steps in the frozen snow we crossed a rather steep glacial couloir beneath the bare cliffs of the mountain, and ascended a series of sharp, screes-covered rock-buttresses coated with snow and verglas from a squall on the preceding afternoon, which not only made the climbing somewhat difficult, but introduced an element of danger should any one happen to lose his foothold. After somewhat more than an hour these buttresses were surmounted and the permanent snow was reached. Here the truth of the report of Savoye and the porters was apparent. A vast wall of ice, covered in places but thinly with snow, soared directly over our heads at a most forbidding angle, and at first glance it seemed impossible that it could be ascended, for near its top it appeared to be actually perpendicular.

Before attacking it we screwed Mummery steel-nails into the soles of our boots. We prefer these nails to crampons for several reasons. They are more convenient to carry, having no appreciable weight and taking but little space in one's pocket, while the crampons make an inconvenient parcel. They can be inserted into any mountain-boot

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having suitably thick soles, and no other should be worn, while, as a rule, in order to fit properly crampons must be made for each pair of boots. Their use also leaves the feet free from the constriction exercised by the straps necessary to attach crampons to the boots, which by interfering with the circulation conduces to frostbite. Roping in two caravans, which kept a little distance apart, we now pushed our way in zigzags up the ice-wall. For a short distance the slope rose at  $50^{\circ}$ , but soon it became steeper, reaching  $55^{\circ}$  and then  $60^{\circ}$ , and then— The Abney's level we were using as clinometer was scaled only to  $60^{\circ}$ . Up to this point it measured correctly enough, but the gradient of the upper part of the wall considerably exceeded this limit, and the instrument could no longer be relied upon to give accurate measurement. Judging the excess over  $60^{\circ}$  by comparison with the graduation of its scale, we were finally climbing on slopes that must have been  $70^{\circ}$  to  $72^{\circ}$ .

At last the wall ahead became so steep that we were obliged to traverse it to its free face, where it fell away to Barmal glacier in an ice-precipice composed of great perpendicular columns, which had







## SUMMIT OF MOUNT NIEVE PENITENTE 135

separated themselves from its main mass as it pushed downward. Here, although the slant was but little less abrupt, the surface was roughened by irregularities resulting from unequal melting under the sun's heat, so that a more secure foothold could be obtained. After another hour of this ladder-like work the brow of the wall was gained, and we found ourselves on a broad shoulder, from which another steep slant requiring step-cutting led up to what appeared to be the summit. On surmounting this we found before us an ascending snow-field leading up to the base of a large rounded cone, the top of which proved to be the actual summit, which was reached at 8.30 A.M.

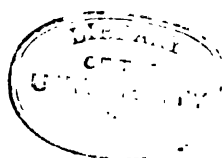
The whole of this cone was covered with nieve penitente, which, glistening in the morning sunlight, suggested the name we gave the peak. From the readings the altitude of this mountain was computed at 19,080 feet. On the east side towards the Nun Kun the mountain breaks down 2000 to 3000 feet to a glacier springing from it and from the southwest side of Ser, which descends to the North-West nala. On the north it falls away nearly as sharply to the Barmal glacier, and on the south in perpen-

## 136 PEAKS AND GLACIERS OF NUN KUN

dicular rock-columns devoid of snow, to the ridge on which the North-West Col is situated. The summit can therefore only be approached from the west by the steep route we used.

The view was of great interest to us, as it included much of the district through which we had groped our way without the assistance of a map or any other source of information, depending on deductions made in connection with the few salient points seen from the other side, which proved to be correct. It also cleared up certain questions about which we had been in the dark, and disclosed new features of importance in determining the topography of the region. North of east, at a short distance, loomed the highest Nun Kun with its frowning precipices and forbidding ice-falls. Beyond it, east by south, rose the great mass of Z1 with the spur and ice-fall ending in the glacier we had traversed. Below it the Z1 nala followed by the Fariabad opening, the North-West nala, the ice-amphitheatre and North-West Col, and above and beyond these the Zaskar snow-peaks. Westward from under our feet swept the Barmal glacier in radiant, snowy curves, contrasting with the green mountain-sides at its lower end.









## VIEW FROM MOUNT NIEVE PENITENTE 137

Rising directly from the head of the glacier on the north, to the formation of which it largely contributes, stands one of the kings of the scene, the sharp, ice-bound, twin-peaked D41, an interesting mountain, which, after studying it, we decided to try to ascend the following day. Mount Nieve Penitente is noteworthy, not only for the formations which graced its upper parts, but also for the sharpness of its middle ice-clad sides, the appalling nature of which was more vividly realised on the descent, when they had, at several points, to be taken turning backwards in our tracks, and every step had to be measured with the greatest care. We hastened with all possible speed in open order across the last snow-couloir at the base, keeping a sharp look-out for stones, which, set free by the melting of the ice which held them, were bounding down over its surface in sufficient numbers to make the passage of it anything but agreeable or safe.



## CHAPTER VIII

**First Ascent of D41—Topography from Summit—Dangerous Descent in Mist—Sudden Snow-squall in Camp—Descent to Tongul and Suru—The Wazir and the Invasion of the Sacred Places—Great Heat—Conclusion of Expedition—Explanation of Map.**

ON our return to camp the coolies, having become tired of sleeping all day on the rocks in the sun and huddling together without fires in their tents and rock-shelters at night, came up with their hands filled with most unpalatable-looking, doughy masses, evidently prepared for the occasion, saying they could not eat their *satu* and were suffering from cold. 'Very well,' was our response, 'you would not bring wood when asked to do so, to keep yourselves warm, and your *satu* was ground only ten days ago, and cannot be bad. Go down if you wish to, but we remain here another day.' Somewhat later the porters reported that the coolies intended to bolt that night, but no attention was paid to the report, as there was every reason to believe the steep, crevassed wall below the camp would serve as a



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their bases, which furnished secure footholds and largely obviated the necessity of step-cutting, though our route was in consequence made more tortuous. Had the surface been smooth, the ascent would have been more difficult, more fatiguing, and highly dangerous.

Toward the top the strain was somewhat relieved by two rock-ledges which cropped out of the snow, but the ice-slants between them and above the higher one were so frightfully steep, as the peak narrowed to a point, that, at that altitude, it required all our strength to surmount them. The lower summit, which we did not visit, is a symmetrical snow-cone, at that time entirely covered with nieve penitente. The higher summit terminates in a sharp rock-ledge covered with slabs of shale, its top overhanging like a cornice on the west side, beneath which is a perpendicular drop of several hundred feet to the lower snow-summit. There is only room at the apex for half a dozen persons to sit or stand comfortably. We reached the top at 10.30, in just five hours from camp. The readings gave its altitude as 20,571 feet.

Standing on such a spire as this, with a clear view





in all directions, one feels as if perched in space overlooking the glories of the mountain-world. Such eerie mountain-tops have an individual character, and stamp themselves indelibly on the memory, while broad ones, although they may offer views of great magnificence, lack character and vanish from the mind afterwards when regarded solely as summits. The view from here, while similar in many respects to that from Mount Nieve Penitente, supplemented it and gave a complete picture of the western aspect of the Nun Kun massif, all its salient points and features on this side being spread before us.

The two heads of the Ganri glacier, from their origin in the Nun Kun basin and in the south-west side of the highest peak and north-east side of D41, to their coalescence just above the gorge descending to the Rangdum valley, lay directly under and before us. The white flow of the Barmal glacier to the west was seen almost to its end, and from this glacier we could trace the route over the Sentik La and down several miles of the Sentik glacier and its moraines to the valleys and spurs beyond, falling away to the distant Suru valley, 10,000 feet below.

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Directly west, at a distance of something over four miles, D42 of the Indian Survey rose from the serrated northern wall of the Barmal glacier, its upper part covered with snow. We are not aware that any measurements were taken by the Indian Survey to determine its altitude, but by levelling off on its summit we judged its height to be of about the same as that of D41. These two peaks may be regarded in a sense as twin-peaks, rising as they do from the same ridge, being of about the same altitude, and being the highest elevations immediately west of the Nun Kun.

A small cairn was built on the highest point of the rock-cornice with such stone-fragments as lay at hand, in which notes of the ascent were placed. As its position was so exposed and the stones with which it was made were not of such shape as to lie compact, it may not long withstand the winter gales. After a hasty meal we turned our attention to observations and photography, which were soon interrupted by the customary exasperating mist, which about eleven o'clock swept in from the west with incredible swiftness, and put an end to work of importance, for which the occasion was otherwise







favourable, and for which there would have been plenty of time.

The mist was accompanied by an icy wind that chilled us to the bone, condensing the moisture into white fringes on our caps and coats and into icicles on the moustaches of the men. There was no knowing when it would lift or what storm influence lay behind it. To remain on that tempest-torn summit without a particle of shelter from the freezing wind, in the hope that it would soon pass over, was a hazardous undertaking, and every minute of such a stay would lessen the chances of a safe descent, should a storm break. A descent in the thick fog down pathless slopes of such character and gradient as those that must be traversed, without any visible landmarks to guide us, was almost as dangerous, but it seemed to us preferable to remaining.

Our effects and instruments were collected, and we started down in two caravans a short distance apart, neither of them visible to the other. We depended entirely on the slight trail made in coming up for guidance, and even this could not be seen twenty steps ahead. We groped our way slowly down among the nieve penitente-pinnacles rising in

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dim spectral forms all around, along creepy arêtes, jumping crevasses the further sides of which could scarcely be distinguished through the white pall, searching here and there for the narrow thread beneath our feet, on which we relied for escape, and calling to the other party, whose answer came like a shrill wail through the gloom.

The path up had not seemed so circuitous, but now it appeared to wind around and over the roof of this world of desolation, and the monotone of fog, by which we were surrounded, made it appear doubly long. The wind-gusts, at times, were accompanied by flurries of snow, which furnished a little variety. When, after unceasing effort, we had safely accomplished the steep upper half of the descent and reached gentler gradients, the mist partially broke, and we sat down to rest and reflect on the fact that D41 is a dangerous mountain in a fog, and that a glorious, sunlit Himalayan peak may suddenly be transformed into a horrible object of foreboding by adverse conditions. Even as we rested the mist closed in again, so we resumed our march campward.

With one thing we have always been satisfied,





when placed in positions of danger from stress of weather or other cause on Himalayan peaks, viz. that we have had with us expert guides, masters of snow and ice craft, and not self-assertive amateurs, who would probably have succumbed to fear or advocated some move leading, perhaps, to fatal consequences. Of recent years, climbing with guides has been severely criticised by certain 'guideless' climbers, especially some who themselves have attempted Asiatic peaks, but have not achieved such measure of success as to entitle their opinion to any great weight. They have characterised guides as ignorant peasants with a taste for alcoholic drinks. It must be confessed that a large proportion of the so-called guides and porters who serve summer tourists in the Alps, and particularly in Switzerland, are open to the charges brought against them, being entirely unfit from their drinking habits and lack of proper training to act as leaders or companions in real mountain-work; but guides who take their occupation seriously, the only ones worthy to be employed, are to be placed in quite a different category. Certainly on the unknown glaciers and peaks of Himalaya, amid many dangers which can

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As to the connection with the Bhot Kol asserted in the last three quotations, the point where Dr Neve supposes the Barmal to join the Bhot Kol is indicated on a section of the Survey map, published with his communication in the February 1903 *Alpine Journal*, as being near the end of the Barmal directly south of Peak No. 10, which stands at the head of the Bhot Kol. To establish this connection he has erased the solid wall, correctly charted on the Survey map, separating the Barmal glacier from a south branch of the Bhot Kol, thus making the Barmal take a sharp turn to north-west instead of going 'due west,' as stated in last quotation, to join the Bhot Kol branch seen on Survey and our map.

It may be noted that Dr Neve has not been any nearer to this point than the head of the Barmal glacier, six miles or more distant, and he has not visited the Bhot Kol and examined the asserted point of junction from that side. Besides having seen from the summit of Mount Nieve Penitente the unbroken rock-wall rising above the Barmal glacier at the point where the erasure was made on Dr Neve's map, we have also examined it face to face and photographed it from a point directly







opposite it on the Bhot Kol side, and have photographic proof that it stands as an insurmountable barrier to a junction of the Barmal with the Bhot Kol at the place indicated. See illustration facing opposite page.

In the evening after our return from D41, just as dinner was about to be served, the mist was succeeded by a violent squall of wind and snow, which partially tore the tents from their fastenings and sent their forward halves flying in the snow-laden air like waving pennons, while their contents were overturned and tumbled over one another in wild confusion. All hands sprang to the rescue, and only by most earnest effort prevented the tents from sailing away bodily over the pass to the glacier below. Nothing could be done to restore order till the fury of the squall abated, so we held on in the blinding snow, listening to the howling of the wind and the groans of the frightened coolies in their shelters among the rocks. In the fracas the khan-samah's fire was extinguished, and the dinner he served, when quiet again reigned, was not of a character to appeal to the palate of an epicure. This incident made evident, what we had already

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foreseen, that the Barmal La was not a spot to tarry at too long.

Being satisfied with the results of our reconnaissance of the region, and with the conquest of two virgin peaks of the very first class, and having placed notes of our work in one of the cairns, we gave the order to break camp and move on. On the morning of 15th August the long caravan filed down the steep ice-wall to the Barmal glacier. The coolies required much helping, and an hour and a half was needed to bring all safely to the glacier below. We then crossed to the north side of the latter, and descended it for more than a mile to the Sentik La, a depression in the rock-wall running west from D41 to D42, and forming the north barrier of the glacier. The altitude of the Sentik La is about 16,500 feet. This pass furnishes a passage to the Sentik glacier, which, springing from the north-west slope of D41, from the wall, and another high ridge running north from it, descends for three miles, the last mile being flanked by high and rough lateral moraines, to the head of a nala enclosed by jagged rock-peaks, leading sharply down to Tongul. Two offshoots from the Ganri glacier descend west in



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and snow-cols from 16,500 to 17,500 feet in altitude, and one precipitous rock-wall, besides many miles of detour in exploring and climbing in the massif. In accomplishing this we were obliged to shape our course by such topographical features as could be seen from points attained.

When we arrived at Suru at noon of the next day, the first sound to greet us was the familiar crow of the white cock, which had arrived before us. With the worn and battered appearance of a veteran campaigner, his plumage even more ruffled than at Base Camp, and with only the stump of a tail, which had served as a handle to catch him by, as long as any feathers remained in it, he was bustling about, busily engaged in initiating his sole companion into the intricacies of the lambardar's courtyard, as if he were the proprietor of the place.

The day after our return a chaprasi delivered an official letter from the Tehsildar, the purport of which was, that the lamas of the Rangdum monastery had complained that the exploration of the Nun Kun and the attempt by our party to ascend its peaks, which were held sacred, would result in 'heavy snow-fall, famine, and other





## OFFICIAL LETTER FROM TEHSILDAR 153

calamities' ; that the matter had been referred to higher authority, and that a telegram had been received from the Revenue Minister at Srinagar (one of the native advisers of the Maharaja), saying we should be told not to invade the ' sacred places ' against the wishes of the lamas. Also that the Maharaja of Kashmir was writing to the Resident on the subject. This, coming as it did after the expedition was finished, and two months after we had passed through the Rangdum and filled the money-loving hearts of the lamas by a liberal distribution of bakhshish, surprised us not a little and amused us more.

We inquired of our agent, who had been in close touch with Kargil, whether he had heard anything of the alleged complaint of the lamas. He said he had not, but some days previously, while returning from Kargil, he had met half a dozen lamas, who told him they were going to Kargil, whither they had been summoned by the Wazir, the highest native official of the region, who was also Native Joint Commissioner for Baltistan and Ladakh.

We gave the matter no further thought at the time, having other more important things to attend



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to. A few days later our agent, who had again been sent to Kargil on business, on his return said he could now tell us more about the sacred places. He had learned on official authority that the lamas, who had been summoned to Kargil by the Wazir, instead of entering a complaint of their own accord against us, had at his command, which they dared not disobey, and at his dictation, sent three or four telegrams to the Maharaja. We asked, 'Why should the Wazir do this?' 'That is easily explained,' he replied. 'The Wazir is a Swadeshi man, well known to be a hater of Europeans. When I first went to Kargil in May, I was approached by one of his subordinates, who gave me to understand that, if he were to receive a hundred rupees, all would go well with the expedition. I declined to accede to his demand, as he had done nothing to further the interests of the expedition.'

This incident affords an example of the dark and devious ways often pursued by native officials to advance their own interests, and it explained a number of obstacles which were encountered by us but failed to stop our progress, including the desertion of the Kargil coolies on the second day out,

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which, we later learned, was due to the direct instructions of the Wazir, and ending in this attempt, which came too late to be of any avail to him or injury to us. Two days later Mrs Bullock Workman received a despatch from the Resident stating that the Durbar complained, that we had invaded the 'sacred places' of the lamas, and asking us to refrain from doing anything to excite local feeling. An answer was sent, that, to her regret, the invasion of the so-called sacred places was complete, that the myth of the sacred places originated in the fertile brain of the Wazir, and that the only local feeling excited in the Rangdum by the movements of the expedition had, apparently, been one of satisfaction. Official inquiry based on this reply disclosed the true facts of the case, also that the lamas held no such fiction of sacred places, and led to the removal of the Wazir, whose record in certain other official matters was found to be unsatisfactory.

In these days, when the most remote places of the earth are open to the explorer, the grand, untrodden mountains can be called sacred only to the Almighty, who has protected them from invasion by barriers sufficiently difficult to be overcome,

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without the addition of any raised by man. The above episode, flavouring strongly of the ridiculous, is cited to show the rapacious avidity of certain native officials in Kashmir. It may also serve as a warning to the future explorer, to set aside a liberal fund to be employed, if necessary, as douceurs to such avaricious officials as may be encountered. Bakhshish, much bakhshish, if he would attain his aim.

The 18th and 19th of August were very warm days at Suru, the sun burning with unusual fervour. We had found during the summer, as during those of 1902 and 1903, sun-maxima of  $200^{\circ}$  to  $206^{\circ}$  Fahr. at altitudes of 12,000 to 15,000 feet to be not at all uncommon, but had never known them to attain the figures reached on these two days. On the 18th at 1 P.M. the sun-thermometer registered  $206^{\circ}$ , and at 1.15  $212^{\circ}$  Fahr. As this last figure seemed incredible, the instrument, which was so hot that it could scarcely be touched by the hand, was raised to the vertical position and shaken, but the mercury did not fall. At 1.25 it reached  $216^{\circ}$ . This was not only an unusually high maximum, but it occurred at an unusually late hour, most





maxima we have observed occurring at or before one o'clock.

On the 19th, at 12.30 P.M. the thermometer registered 196°; at 12.45 213°; at 1, through a thin film of cloud, 217°, not falling when placed vertical; and at 1.5 219° Fahr. The altitude of Suru is 10,850 feet. As sun-temperatures increase in proportion to altitude, what must the temperature on these days have been at over 20,000 feet? On these, as on other occasions when we have noted high temperatures, the maxima showed themselves in sudden waves or flashes of heat lasting a few moments and then subsiding. It may also be noted that, as on the 18th, some of the highest temperatures have occurred when the sky was covered with thin cirrho-stratus clouds. During this summer we did not have the opportunity of obtaining sun-maxima at very high altitudes, as, on nearly all the days which we passed at above 18,000 feet, the customary mist and clouds, which appeared towards noon, cut off the rays of the sun during the time, 12 to 1.30 P.M., when they are hottest.

The following table shows the sun-maxima taken with black-bulb thermometer on those days in 1906

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when opportunity offered to take it, together with shade-temperatures at same time and minima on preceding nights.

Date.	Place.	Altitude.	Time.	Max.	Shade.	Min.
		Feet.	P.M.	Fahr.	Fahr.	Fahr.
June 21	Kargil . . .	8,787	1	199	78	50
" 22	Chalis Kot . .	9,000	12.45	203	64	...
" 24	Suru . . .	10,850	1	196	74	...
" 25	" . . .	"	12.45	200	72	54
						8 A.M.
" 28	" . . .	"	12.30	206	74	46
July 1	Rangdum Valley	12,900	12.50	204.5	64	28
" 8	Zulidok . . .	13,270	12.40	205	58	26
" 13	Shafat Nala . .	13,325	12	200	63	20
				(moving clouds, probably not maximum)		
" 15	" . . .	"	1	191	60	22
Aug. 2	Base Camp . .	15,100	12.40	183	54	36
" 3	" . . .	"	1	166	57	31
" 4	" . . .	"	12.45	167	62	30
" 8	" . . .	"	12.30	176	56	30
" 18	Suru . . .	10,850	1.25	216	71	...
" 19	" . . .	"	1.5	219	72	50

For similar tables in 1903 see *Ice-bound Heights of the Mustagh*, pp. 200, 270-274.

At Suru the expedition ended. The coolies were paid off and disbanded, and, two days after our arrival there, the guide and porters started on their return to Srinagar *en route* to Europe, accompanied by all camp-attendants except our personal servants, while we ourselves remained a few days longer to settle matters pertaining to the expedition.

On the morning of 22nd August we left Suru to

cross the mountains by the Umba La route to Dras, and thence over the Zoji La to the Sind Valley, and by this to Srinagar. The last sounds heard, as we crossed the river just below the village, were the cheery notes of the cock bidding us a final farewell and Godspeed. Although in need of fowls, which could not be procured, we felt that his unfailing courage under the vicissitudes of the march, heat, thirst, starvation, and rough usage, and his inspiring example, entitled him to his life. So we left him in his glory in his native village, with the hope that no untoward circumstance might prevent him from living out the full measure of his days.

In conclusion, a few words as to our map of the Nun Kun which accompanies this book. The Indian Atlas Sheet No. 45 S.W. of the Indian Survey was taken as a basis. Its fixed points, except in two instances where they were manifestly in error, were employed as points of departure, and changes were made only where actual inspection of the portions of the region explored, aided by prismatic compass-observations and photography, showed the Survey map to be incorrect. The only change made in a detail not really seen was, as has been said, in



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representing the drainage of the Barmal glacier as passing into the Bara Zaj Nai. This was done because the topographical indications of such drainage, from features which were seen, are so strong and the likelihood of the escape of the water in any other direction so remote that it appears justifiable. The lengths of certain details on the map are less than we judged them to be in reality, but these could not be made greater without encroaching on space devoted to other details on Survey map. For the general correspondence of such details with the actual topography we can, however, vouch.

As alterations have only been made along the route we travelled or in parts that could be plainly seen from it, some other points on Survey map, which there is reason to think might be altered with advantage, have been left as charted on it, since we do not consider that alterations should be made without a certainty as to the real topography. Hence, if future investigation should show that these are incorrect, we do not assume any responsibility for them.

As examples of some of the features of the Survey map requiring correction, which rendered our circuit





## INCORRECT FEATURES ON SURVEY MAP 161

of the Nun Kun massif, perhaps, more puzzling as pioneering-work than it would otherwise have been, may be mentioned the following. South of the Nun Kun the course of the North-West nala is represented as occupied by a mountain-spur, no nala being indicated. West of the massif, D41 is placed a mile too far south, nothing corresponding to Mount Nieve Penitente can be found, and the arête leading from the highest Nun Kun peak to the Barmal Ridge is drawn too far north, ending in a peak instead of a ridge. The head of the Barmal glacier is occupied by a solid mountain-mass, and the peak D42 is placed in the centre of what should be the course of the Barmal glacier, being shown some two and a half miles too far east by south on a spur which does not exist. What should be the tongue of the Barmal glacier is represented as the reservoir of a glacier, which, running north-east, cuts across the space occupied by the mountain-ridge connecting D41 with D42 and drains into the Suru river, a wholly false topography, the incline of the watershed being west and south from the D41 and D42 ridge.

The above is not mentioned in criticism of the Survey, the difficulty of the problems confronting

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which in making a map of such a complicated region as the Himalayan must be apparent to those who have to any extent explored its recesses, but to show that accuracy of detail can only be ensured by direct observation, which in a considerable portion of this region the Survey had not the opportunity to exercise. It is well known that the work of the Indian Survey in the northern part of Kashmir territory had to be, in the circumstances under which it was carried out, more in the nature of a reconnaissance than of a finished survey, salient points being fixed and intermediate details, which could not be seen, filled in on the map by inference, with a greater or less approximation to the reality according to the deductive power of the surveyors engaged in it. In some cases such inferences were wide of the mark, while in others they came surprisingly near the actual topography. It cannot, therefore, be regarded as discourtesy towards the Survey for those exploring the hitherto unvisited intermediate parts to mention, in the interest of Geographical Science, the absence or inaccuracy of topographical details on the map.

## CHAPTER IX

Nieve Penitente, where seen—Definition and Shape—Views as to Development—Ridges in Névé—Classification according to Antecedent Cause into Varieties — I. Avalanche — II. Subsidence — III. Wind-Conditioned—IV. Thin Débris—V. Glacial Table—VI. Thick Débris—VII. Lacustrine or Composite—VIII. Sérac.

FREQUENT mention has been made in the preceding pages of nieve penitente seen by us on the Shafat glacier and on Mount Nieve Penitente and D41, six miles west of it. This curious and interesting formation was first noticed and described by Andean explorers. For a long time it was supposed to be peculiar to that chain, where it has been met with from the equator to  $35^{\circ} 40'$  lat. S. It has also been seen as far north as Mount Shasta in California,  $41^{\circ}$  lat. N. Later Dr Hans Meyer, Dr Karl Uhlig, and Dr F. Jaeger found it on Mount Kili-mandjaro in Equatorial Africa, and in 1906 it fell to our lot to discover it in Himalaya  $34^{\circ}$  lat. N., as above stated.

This was the first time in five seasons of Himalayan

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exploration that we had met with it, and, so far as we are aware, its existence in Himalaya has not been mentioned by any other observer. In 1907 Herr Hans Spethmann found and studied in Iceland areas of small, dust-covered pyramids, which he calls 'Schneeschnitzkegel,' but which, as shown in his photographs, appear to be well-developed *nieve penitente*. He mentions the same formation as having been described by the geologist F. Keilhack in 1886. Similar formation in a rudimentary state is mentioned by Professor Dr Eduard Brückner as having been observed by him on the Rhone glacier in August 1898.

In 1908, while exploring the Hispar glacier and its branches and the Biafo glacier on the northern frontier of India,  $36^{\circ} 14'$  lat. N., we again found *nieve penitente* widely distributed and occurring under a variety of conditions. In all probability, as this formation becomes better understood, it will be discovered, under favouring conditions, in other places where it has not hitherto been seen. Although the mention here of observations made in 1908 on the Hispar and Biafo glaciers is anticipating the report of that expedition, they have so important a











## DEFINITION OF NIEVE PENITENTE 165

bearing on the subject in hand that the authors have concluded to use them, in connection with those made in the Nun Kun, in support of conclusions arrived at.

By *nieve penitente* is understood a greater or less collection of pinnacles of ice or hardened snow standing on *névé*-surfaces of mountain-slopes and glaciers, or on glacial ice below the *névé*-line, and, in some cases, on earth or rock. These pinnacles are usually arranged in rows, often quite close together, and range in height from a few inches to six feet, and sometimes considerably above that. Their form varies greatly. Some stand in square or cylindrical columns with flat tops. Others are conical, many of these being slender with sharp apices, and the apices may curve so as to resemble curving horns. Others still are wedge-shaped, the upper edges being often exceedingly sharp and serrated. But by far the greater number are more or less regularly pyramidal, most of such being flattened on two opposite sides so as to present a long and a short axis. This may be regarded, perhaps, as the typical form. The long axis is usually coincident with the direction of the lines in which

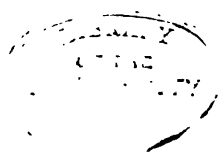
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they stand. When of large size, they present a very weird and bizarre appearance, and, when arranged closely together, may render the passage across a surface on which they stand difficult or impossible.

They occur in the great majority, if not in all cases, at altitudes at which the temperature at night falls below the freezing-point. We have seen them at altitudes of from 15,000 to over 20,500 feet. They also occur in localities, where plentiful snow-fall during the winter is succeeded by a continued period of fine weather lasting several weeks during the summer. In stormy summers with repeated snow-storms they are not formed.

In view of these circumstances, as well as of the appearance of the projections themselves, most observers agree that *nieve penitente* results from the unequal melting of the snow and ice, portions of which disappear under the application of heat, and other portions remain in the form of pinnacles; and that the chief agent in the melting-process is the sun, though observation also shows that heat contained in clouds and air plays an important rôle. When, however, we come to the question, why heat should melt snow and ice in this unequal manner, we find





great diversity of opinion among observers, most of whom have been men trained to observe carefully and to make logical deductions from facts that have come under their notice.

Professor Hauthal, who saw *nieve penitente* only in windless localities in the Argentine Andes, concludes that the sun has power in virtue of its position and course, or from some peculiarity of its rays, to melt a homogeneous field of *névé* into the characteristic pinnacles arranged in rows, independently of assistance at any stage from wind. Few other observers agree with this view. Most, such as Dr Güssfeldt, Dr K. Uhlig, Dr W. Deecke, Dr Hans Meyer, and the authors, having seen *nieve* in wind-swept places, consider that, in many cases, wind also is concerned in the process as an antecedent factor, raising the snow while soft into parallel ridges and wavelets, or causing a difference in its internal structure, that influences the effect of the sun's action later.

Various other views as to details of development have been expressed, and various sidelights have been thrown on the subject based on observations in different localities, but no comprehensive statement

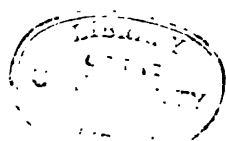


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of a mode of development has heretofore been brought forward, that has received universal recognition. Too many facts militate against Professor Hauthal's view to render it tenable, and observations point with absolute certainty to the operation of other causes anteriorly to or coincidently with the action of the sun. The diversity of opinion that has existed indicates, what our experience has shown to be the case, that *nieve penitente* exists in several different varieties depending on the operation of different causes, and that different observers have seen it under different conditions. Some of the opinions, therefore, that have been held, while not sufficiently broad to account for the formation of all varieties, are in the main justified by the features of the varieties that have come under the notice of their authors.

As the action of heat, whether derived from the sun or otherwise, does not appear adapted in itself to melt a homogeneous surface in the manner seen in *nieve penitente*, it is reasonable to assume, even were proof not available, that antecedent differences in density or physical condition of different portions of *névé* must exist, which determine whether the





action of sun and heat shall result in the development of *nieve penitente*. The *névé* must be transformed into alternate hard and soft perpendicular strata and centres, the softer of which melt more rapidly under the effect of heat than the harder.

A careful study of *nieve penitente* as seen on the Shafat glacier in 1906, in the causation of which wind and sun were the principal factors, though assisted by evaporation and the heat contained in the air, led to the conclusion that the *névé*-shafts, pinnacles, and pyramids, constituting *nieve penitente* result from the action of heat, whether applied by the sun's rays, or by reflection, or by warm air currents as observed by Dr Meyer, upon *névé* and glacial surfaces in which condensed foci or centres have been formed antecedently by different causes, melting away the softer portions and leaving the denser ones standing as upward projections.

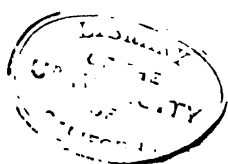
The grounds on which this conclusion is based are set forth in the *Zeitschrift für Gletscherkunde*, Band II. Heft I. 1907, p. 22 *et seq.*, in the January 1908 *Geographical Journal*, pp. 17-22, and in a more detailed form in the May 1908 *Alpine Journal*, pp. 139-148.

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During our expedition to the Hispar and Biafo glaciers in 1908 *nieve penitente* was met with in great quantity under different conditions. Being convinced, both from previous experience and from what was here found, that the melting action of heat, however derived, is only a secondary and final factor common to the development of every kind of *nieve*, and that the sun possesses no special power, other than that of a supplier of heat, in virtue of its position or course, attention was given to the more complicated and less understood question of the antecedent transformation of *névé* and glacial surfaces, and to concomitant conditions, that enable heat to sculpture out *nieve* from them. As a result of careful observation of the ample material found it was possible to divide *penitentes*, according to the antecedent causes, into eight different varieties, the first including three sub-varieties.

The months of July and August were passed on these glaciers. During the greater part of June and July the weather was clear and warm, many days in succession being cloudless, so that, as was the case in the Nun Kun region in 1906, the season





was favourable to the development of nieve penitente. Also, no new snow was met with, even to an altitude of 19,500 feet, until the first week in August.

Attention was early attracted to a very marked feature of the sloping névé-surfaces of the region of the Hispar glacier and its branches, whether the névé lay in isolated beds or covered large areas of glacier or mountain-slopes, viz. that they were almost invariably striated with parallel ridges separated by furrows. These ridges on many of the higher surfaces were caused by wind, in other places by avalanches, and in others, apparently, by the settling down and condensation of the névé on rather sharp slopes. The snow composing the ridges, even on higher glacial surfaces where the névé was of recent formation, was, as a rule, denser than in the hollows, bearing the weight of a man, where the latter would not, thus showing that, in whatever way the ridges were formed, they were of denser structure than the snow of the hollows between them.

These ridges ran almost without exception in the same direction as the incline of the slopes, and, as different slopes inclined in different directions, they



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oriented in different cases to all points of the compass. When a given slope changed its course, its ridges changed theirs to correspond. If a slope diverged at its base like an opened fan, its peripheral ridges likewise diverged, and on converging slopes they converged towards the central line.

The wide distribution of such ridges on sloping névé leads to the conclusion that moving snow, whether it moves rapidly as when driven by wind or in an avalanche shooting over a sloping surface, or by the slower process of settling downward, tends to accumulate in columns vertical to the surface with a direction coincident with the direction of motion, which latter is determined by the shape and inclination of the slope. The same tendency was observed in the Nun Kun in 1906, where the penitentes-pyramids ran in lines also orienting with the slopes. Ridges having become converted into ice were found to persist as longitudinal surface-ice-ridges for two miles or more below the lower limit of névé, their direction coinciding with that of the descent of the surface they formed a part of.

Now these ridges are of importance to the subject in hand from the fact that, while on many surfaces



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ridges with ragged sides running in the direction of the inclines of the slopes and of the courses of the avalanches, in the first case due north and in the second north-east. The ridges were crowned with shafts and projections of various shapes undergoing modelling by the sun, a large number of which had been converted into typical penitentes-pyramids with their long axes parallel to the ridges. Some were stratified horizontally, dark, dust-stained layers alternating with white ones of pure *névé*. Their height varied from eighteen inches to six feet. Some were evidently developed from blocks brought down by the avalanches, but many, perhaps the majority, were formed from snow-foci condensed between the pressure of the moving snow behind and the resistance of that in front.

An even more pronounced example was found at an altitude of 15,900 feet on a large avalanche-bed at the base of an enormous ice-wall. Here the surface was torn up to a far greater extent than in the preceding instances, but everywhere a certain order prevailed. The *névé* and ice-blocks, although scattered over all parts of the bed, were arranged, largely, in lines following the path of the avalanche





## FEATURES OF AVALANCHE-PENITENTES 175

and parallel to one another. The more finely divided and pulverised portions of the avalanche-débris had formed ridges, ragged but distinct, also parallel to one another running in the same direction. The tremendous power, that had hurled the masses of ice and snow thousands of feet down the mountain-face, had condensed the snow of these ridges into centres, which the sun's heat was in some cases fast moulding, and in other cases had already moulded into *nieve penitente*-pyramids.

Many of the smaller blocks had also been fashioned into pointed columns and pyramids, some with their long diameters parallel with the ridges and some with the same transverse to them, according to the original shape of the blocks. It may be noted that the ridges in all parts of the area were parallel to one another and oriented from south to north, coinciding with the direction of the glacial slopes at this point and with the avalanche-path. Not one transverse ridge was seen. Many of the ridges and some of the blocks showed marked stratification. The height of the pinnacles ranged from three to six feet.

In these three instances the avalanches that

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conditioned the nieve were originally composed, largely, of solid material, which, first falling perpendicularly, was much broken up in the descent. On reaching the névé-slopes the mixed débris tore its way for some distance down them till stopped by friction and gravity. In such cases the factor of forward motion is, without question, the cause of the arrangement of the débris in lines and ridges, in which centres of condensed snow are formed by resistance in front and pressure from behind. Avalanche-beds were seen at the base of ice-falls, on which nieve-pinnacles were scattered about without arrangement in lines. In these cases the pinnacles were fashioned from ice or névé-blocks, which had not moved any distance forward after striking the glacier.

We now come to another order of avalanche-conditioned nieve, viz. where avalanches of snow slide down over sloping névé-surfaces. Here longitudinal ridges are formed, crowned largely, if not exclusively, by nieve of the pyramidal type. A bed of this kind, about a third of a mile in length, on the steep slopes near the Nushik La, the whole length of which was followed up, afforded an ex-







cellent example. It varied in width from forty-five to sixty feet, and it formed a stripe from four to eight feet thick superimposed upon the névé-surface. It was divided into several longitudinal ridges, varying in number in different portions, all orienting from east to west, in the line of descent of the slope and of the avalanche, which were crowned throughout their whole length with perfectly developed nieve-pyramids, flattened on two opposite sides and tapering from base to summit, their long diameters being parallel to the ridges. The pyramids were composed of dense névé, and varied from fifteen inches to three feet in height.

In another instance a snow-avalanche, issuing from a narrow gorge above the Kanibas branch of the Hispar glacier, descended upon a sloping névé-surface, at first due west, but at the lower part it turned nearly south. Its bed was, like the last, covered with longitudinal ridges bearing well-formed nieve-pyramids, their long diameters coinciding with the direction of the ridges, only one transverse pyramid being noted. Both ridges and pyramids, at first orienting east to west, turned with the course of the avalanche and finally oriented north to south,

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showing, perhaps, even better than in the preceding instance, that the condensed foci forming the pyramids were developed by pressure in the direction of descent of the avalanche and not transversely to it. None of the pinnacles of the forms above described were crowned with hoods, but some had strongly curved apices.

Still another kind of avalanche-nieve was seen at several points high up on the mountains at an altitude of 19,000 feet on the watershed between the Hispar and Biafo glaciers. The avalanches here were composed of new, soft snow, which slid down steep inclines and lodged where it struck without travelling forward to any extent. The pinnacles were of rather indefinite shape, and were arranged in rows mostly transverse or inclined at different angles to the line of fall, though in some places coincident with it. Their crests were feathery and greatly serrated. Their substance was porous, lacking the density of pinnacles modelled from more consolidated material. Still their development from denser centres could be traced.

While on the Hispar glacier we had an opportunity to watch the descent of more than a dozen large





## RIDGES FORMED BY AVALANCHES 179

avalanches daily from its snow-covered mountains, and to study the arrangement of their material, as it swept over and settled itself on the surface beneath. As these avalanches, usually composed of rather finely divided material, thundered down the ice-covered slants, they were resolved by the channelled and ribbed surfaces, and even by the smooth ones, into columns, which descended in spray-like streams accompanied by rolling clouds of snow-dust upon the névé-slopes and fans formed by the débris of former avalanches. When the snow-clouds cleared away, the avalanche-tracks were seen to be covered with longitudinal ridges with more or less serrated tops, the peripheral ones being most sharply defined, and, in case of fans, diverging with their diverging contours. The only factor necessary to convert these into *nieve penitente*, as had already been done in similar cases, would be the action of heat for a sufficient length of time.

Frequent observation would suggest that, the more finely divided the avalanche material and the greater the horizontal or forward distance travelled after striking, the greater is the chance of develop-

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ment of typical nieve penitente in lines on an avalanche-bed.

II. Dr Meyer in *In den Hoch-Anden von Ecuador*, p. 437, suggests that, on slopes not sufficiently steep to give rise to avalanches, the settling and downward movement of snow, though it may not be great in distance, causes strata of different density to form through pressure, with their surfaces perpendicular to the direction of pressure, which the heat of the sun differentiates into ridges and hollows. The following observations testify to the truth of this suggestion, except in one particular, where they show that the surfaces of the strata are coincident with the direction of pressure or downward movement, and not perpendicular to it. They further show that foci of special density are formed in the denser strata (or ridges), which condition the development of nieve-pinnacles.

One among many examples seen may be described. A bed, composed of old, consolidated névé, filled an angle between two mountain-slants just above the surface of the Haigatum branch of the Hispar glacier. It had the form of a fan, sloped down at an angle of  $45^{\circ}$  to the glacier, and faced directly







south-east. Its surface from the upper edge downward was scored with longitudinal, not transverse, ridges, of which four central ones ran parallel to the central line. The others diverged as the fan broadened, following the lines of descent of the *névé*-columns, of which they formed the upper parts. On the east side the fan descended considerably lower than on the west, corresponding to the fall of the glacier, and this lower corner turned to the east before joining the glacier. The two peripheral ridges on this side turned with the slope, their upper parts orienting south-east, and the lower directly east.

The summits of these ridges were sculptured out into small but perfectly formed *nieve*-pyramids with rounded tops, their long axes coinciding with the direction of the ridges. This was not an avalanche-bed, no snow lay above it, and its surface was free from detritus. Its inclination was sufficient to cause it to settle as suggested by Meyer, and the results were evident in the production of longitudinal strata containing denser foci, which formed the basis of *nieve*-pyramids.

At the head of the Jutumaru branch of the Hispar, at an altitude of 15,500 feet, several much larger

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névé-beds were seen presenting similar characteristics. They were also fans of old névé sloping at  $35^{\circ}$  to  $45^{\circ}$ , facing south, and banded with ridges covered with nieve-pyramids, which oriented south-east, south, or south-west, according to the spread of the fans. This variety of nieve was found widely distributed on mountain and glacial slants, always on well-consolidated névé. The pinnacles were of moderate size, averaging one and a half to two feet in height, of regular shape, and destitute of hoods.

III. When the névé-covered surface of glacier or mountain is transformed by wind into centres or foci of increased density, which form a basis for the development of nieve. This variety was discussed at length in the three papers above referred to. It was found covering large areas of the higher névé-surfaces of the Hispar and its branches and of the surrounding mountains, at points removed from avalanche action and not sufficiently inclined for the formation of foci by sliding or subsidence. The nieve penitente on the Shafat glacier in the Nun Kun was wholly of this variety, and conformed to the features here seen, except that a large proportion of





## WIND-CONDITIONED NIEVE PENITENTE 183

its pinnacles were wedge-shaped and many had overhanging hoods or fringes.

The pinnacles here were almost invariably pyramidal, and ran in wavy, parallel lines coincident with the direction of the slopes. Where the latter changed their direction the nieve-lines did the same. The pyramids were of medium size, varying from twelve to thirty-six inches in height, with evenly rounded summits, on which but few hoods were seen. Their bases were separated by oval fossae. Where contiguous surfaces sloped in different directions the lines of nieve on them did the same, and the lines on one slope often cut those on an adjoining one at right angles. The banks of glacial streams were covered with nieve of this description orienting in all directions according to the windings of the streams.

The snow-fields above the Nushik La, at an altitude of 18,000 feet, were covered with small but very perfectly developed nieve in lines following the curving surface, resembling in arrangement ripple-marked, sandy, sea-beaches. The pyramids were eight to twelve inches high, and were crowned with fringed hoods, that glistened in the sunlight like myriads of diamonds. These were, without ques-

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tion, developed from snow-wavelets traced by wind on that mountain-top with all the delicacy of frostwork.

The suggestion was made by Dr Workman in the papers above referred to, that the nieve-pyramids of one season, if not melted entirely away, might serve as bases on which the wind might build new foci for future pyramids. This was verified on the higher portions of the Jutumaru glacier, where nieve-covered beds of white *névé* deposited the preceding winter alternated with areas of older, denser, dust-stained *névé*, which bore the ridges and truncated, though still well-marked, pyramids of an older nieve-formation. The ridges of the latter were continuous with those of the former, and, when the pyramids of the more recent *névé* were removed with the ice-axe, those of the older, on which they were resting, were laid bare.

It may sometimes be difficult to distinguish ridges and penitentes due to the antecedent action of wind from those due to subsidence. In such cases consideration should be given to the slopes on which they are situated and to the character of the ridges and *névé*. Where the ridges or lines of penitentes







## FEATURES OF VARIETIES II. AND III. 185

are due to wind, although parallel to one another, they run in a wavy or somewhat serpentine course, occur on level or gently sloping surfaces, and are usually composed of recently deposited, clean and white *névé*; while in the subsidence variety the ridges have smooth, regular sides and run in straight lines, unless the slope they stand on curves, when they curve with it as do those of the wind variety, and the penitentes crown the ridges instead of, as in the wind variety, often standing in lines, the ridges between which have mostly disappeared. They occur on old, well-consolidated *névé*, often much discoloured, and on slopes of decided inclination.

It has been suggested by some observers that the differentiation of *névé* into ridges, and of these again into *nieve-pinnacles*, is due to the melting and erosive action of running water, but no satisfactory evidence of the manner in which such a process may occur has been presented. In no instance, where ridges and penitentes of the avalanche, subsidence, or wind-varieties have been observed by us, has any free or running water been noticed nor any evidence that their formation has been influenced by it, such water as may have resulted from melting

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of the névé having either evaporated or settled into the névé so as not to be perceptible to the eye. The evidence of our observations has all been in favour of differentiation occurring in consequence of the greater resistance to the effect of heat of denser centres formed as stated.

IV. A fourth variety of nieve was found on the Hispar and its Jutumaru branch, on those portions where the névé had melted away or become converted into granular or even denser glacial ice.<sup>1</sup> Between the pinnacles the surface of the glacier was honeycombed with pockets or pools of various sizes with perpendicular walls, at the bottom of each of which was a thin layer of finely divided earthy material, gravel, or one or more thin fragments of shale. The shape of the vast majority of these pools was oblong, the long diameters orienting east and west, so that on the Jutumaru glacier, descending from north to south, the lines of pinnacles projecting above them cut perpendicularly across the longitudinal glacial ridges, while on the Hispar, descending approximately from east to west, they

<sup>1</sup> The next four varieties occur under conditions quite different from those obtaining with the three preceding ones, being found only in association with deposits of débris in different forms on a glacier.









coincided with the trend of the ridges they crowned. In some places the long diameters of the pools oriented north and south.

As the melting due to the absorption of the sun's heat by the dark-coloured earthy deposit proceeded, the dividing-walls between many of the pools disappeared, and the latter coalesced into larger pools. Where these were situated on slopes, many discharged their water and remained as furrows, always deepening by the melting caused by the material lying at their bottoms. The melting of the glacial surface beneath these deposits left prominences of ice between the pools, which were shaped by the sun into nieve-pinnacles of various sizes. These, in spite of the great amount of earthy and petrous débris scattered over the surface, were composed of clean ice. They varied in height from six inches to six feet, the smaller in many instances tapering to sharp points, while the larger had softer outlines. Many of the sides were perpendicular instead of sloping, the detritus having cut its way into the ice perpendicularly.

The regularity in arrangement of the earthy patches, as well as their oblong shape, suggest that



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they were deposited, originally, as little wavelets upon the névé-surface by wind. The same might be true of the sand and gravel-patches, but it is not so easy to account for the shale-splinters intermingled with the finer débris at a distance of five miles or more from the mountains from which they appeared to be derived.

V. A fifth variety is connected with glacial tables. This was found only on ice from which the névé had disappeared, or on ice covered with rock-débris, often so thickly that the nieve-pyramids were the only ice to be seen, appearing to stand on débris, though really their bases were continuous with the ice beneath. These were met with on the Hispar and its Kanibasar and Jutumaru branches, the last being covered throughout its whole length, below the névé-line, with myriads of glacial tables, the tops of which consisted of granite-boulders. They were also seen in great numbers on the Biafo glacier, and on the Skoro glacier south of Askole.

The process of development appears to be as follows. Boulders of rock fall on a glacial surface. Their weight, often amounting to hundreds of tons, compresses the névé beneath them into columns

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much denser than the surrounding névé. Owing to this density and to the protection from the sun's rays afforded by the rock-covering, which is too thick to permit the sun's heat to be transmitted through it, these columns persist as shafts, somewhat diminished in diameter by reflected heat, supporting the rock-tops, after the surrounding névé has disappeared. At this stage we have the glacial table, often with a shaft six to nine feet or even more in height, the névé of which the shaft was originally composed having become converted into ice through pressure, thawing, and freezing.

At first the rock-top sits level on its shaft or pedestal. After a while, the sun passing over it somewhat to the south and warming its southern face more than the northern, and the reflected heat likewise warming its southern under edge, the heat thus conducted to the shaft on that side causes its upper edge to melt faster than on the northern side, with the result that the top begins to tilt to the south. This process continues in an increasing degree, till finally the top slides off on the glacier, leaving the shaft standing behind it.

As the top tilts, the shaft, melting on one side and

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remaining intact on the other, assumes more and more the shape of a wedge of pyramid, the angles of which are rounded off by direct and reflected heat, so that, often, when the top slides off and sometimes before, a nieve-pyramid has been fully formed, and in some cases more than one. In most cases the shaft is left with a bevelled upper surface, which soon sharpens off to a point or edge.

On the Jutumaru, Kanibasar, and Biafo glaciers, which descend towards the south, the glacial table-tops slid off without exception in the quadrant from south-east to south-west, mostly south. The same was, in general, true on the Hispar, which descends towards the west, many here sliding off south-east or against the slope. On the Skoro glacier, falling towards the north, they slid off on the south side or against the slope.

The pinnacles of this variety were higher and more massive than those of any other, except the one next to be described and the sérac-variety, their size being usually proportioned to that of the boulder covering the shaft from which they were developed. Many exceeded six feet in height. They had pointed or rounded apices without hoods. They





## DEVELOPMENT OF TABLE-VARIETY 191

were composed of granular or crystalline ice. They stood both single and in groups, the latter arrangement being due to the pre-existence of several tables close together or to the development of several pyramids from a single shaft, owing to the formation in it of different columns of unequal density under the unequal pressure of the uneven lower surface of the superimposed boulder. In many instances boulders had slid off from their original pedestals to surfaces somewhat lower, the former having been transformed into nieve-pyramids behind the boulders, beneath which in their new positions new pedestals were in process of formation.<sup>1</sup> The pyramids oriented in every direction, the trend of their long axis being, doubtless, determined by the shape of the original columns from which they were derived.

Reflected heat plays a prominent rôle in the development of this variety. Much of the modelling is due to it, especially of the upper portions of the shafts, which are protected by the rock-tops from the sun's direct rays, except for a brief period at sunrise and sunset. The melting of these protected portions to a greater degree than that of the bases

<sup>1</sup> See illustration opposite p. 180.

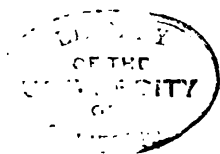


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of the shafts, which are exposed to the sun's direct rays, thus producing a pyramidal form, shows how effective as a modelling agent reflected heat may be. To the effect of reflected heat must be added that of the heat contained in the air and the vapour it carries, and of evaporation taking place from exposed ice and snow-surfaces.

VI. Another form of *nieve* analogous to the last, in which the projections were capped with earthy material, sand, or gravel, was found in great numbers on the lower three-quarters of the Biafo glacier, to a much less extent on the Hispar and its branches, and on the Skoro glacier, at altitudes between 11,000 and 15,000 feet. This was seen in a few instances on *névé*, both on the above and on the Shafat glacier in 1906, but mostly along the courses of medial moraines and boulder-strewn stretches, where *névé* had disappeared, dotting plain ice-surfaces, ice-slants, the sides of *séracs*, and forming serrated skylines on sharp ridges. The projections, which had the form of cones, pyramids flattened or fluted on sides, wedges, and ridges, occurred single, in groups, and in lines, and oriented in every direction irrespective of inclines.





They varied in height from three inches to ten feet, and one thirty feet high was met with. Many were symmetrical in shape, others had one or more buttresses running out from the apex in sharp ridges. In all cases the apices and ridges were covered with detritus, as well as more or less of the slanting sides, and in some the whole pinnacle was concealed from view under a thick deposit. Where the covering was thickest the ice projected highest, and large pyramids were often studded with smaller ones, as well as with ridges covered more deeply than the ice around them.

A considerable portion of the Biafo glacier, where these existed, was banded with perpendicular longitudinal strata. These passed through the pinnacles, often cutting through their apices, thus affording proof that this form of *nieve* was developed out of glacier ice. All pinnacles, even the smallest, were composed of compact, crystalline ice, destitute of air bubbles and breaking with a vitreous fracture, quite different from the soft, aerated ice around them.

The development of this variety may be thus regarded. Patches of mud or sand are deposited

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on a glacial surface either by wind or water action or in some other way not apparent. These, of considerable thickness, protect the ice beneath them from the effect of heat, while the exposed surface around melts away, leaving the protected portions as raised projections. As melting proceeds, the mud or sand at the periphery of the projections falls away and lodges at the bases, thus protecting the latter, but leaving the upper edges exposed, which then melt, giving the projections a slanting form. This process continues, melting occurring whenever the covering falls away, and diminishing or ceasing where it lodges, until the characteristic formations are fully developed. Their size, form, and direction of orientation, obviously depend on those of the original deposit.

VII. A seventh and, apparently, rare variety of nieve was met with on beds of hardened névé lying at the bottom of depressions and clefts in the Hispa glacier opening on a glacial lake. The surfaces of these beds were divided into triangular and quadrilateral pyramids from ten to fourteen inches high arranged with great regularity, each pyramid connected with those around it by sharp ridges. These





were covered with fine, black mud, thicker over the apices and connecting ridges than in the hollows, that on the apices being thickest. The beds bent around in various directions with the windings of the clefts in which they lay. One surface near the lake had been under water only a few hours before it was seen. It was covered with thin plates of ice lying between the apices and ridges of the pyramids, from beneath which the water had escaped owing to the falling of the level of the lake. These ice-plates glistening in the sunlight gave the surface the appearance of the faceted mirror-rooms seen in old palaces.

After careful examination of this formation and of the surrounding conditions, the conclusion was reached that it was developed as follows. The névé-beds in the clefts were first differentiated into prominences of denser and depressions in the softer material by wind or subsidence. They were then submerged by the formation of the lake in water, which deposited mud upon them, more thickly on the ridges and apices than in the hollows. Possibly, however, the water may have melted or condensed the névé into this uneven condition after immersion.



## 196 PEAKS AND GLACIERS OF NUN KUN

The falling of the water again uncovered the beds, which were then further developed by exposure to the sun's heat under the conditions of variety VI.<sup>1</sup>

It is evident from the foregoing, that débris on a glacial surface may, according to its nature and the conditions of its deposition, induce the development of four distinct varieties of *nieve penitente* having quite different characteristics, though they may occur in association with one another. In one case the débris, being deposited on the ice in very thin layers, exerts its effect by absorbing and transmitting the sun's heat so as to cause the ice beneath it to melt, while the intervening ice remains intact. In the other three cases the deposit is of considerable thickness and protects the ice beneath from the action of heat, by which the glacial surface around it is melted away.

VIII. An eighth variety was that developed on and from séracs. This was seen among the séracs of a steep ice-fall on the Kanibasar glacier and

<sup>1</sup> If the reader desires more detailed information regarding this or other varieties of *nieve penitente* described in this chapter, he is referred to an article entitled 'A Study of *Nieve Penitente* in Himalaya, Paper No. 2, by Dr William Hunter Workman, in the *Zeitschrift für Gletscherkunde*, Band III. Heft iv., 1909, pp. 241-270, and to a preceding paper on this subject in the May 1908 *Alpine Journal*, pp. 139-148.





among those of the lowest ice-fall of the Biafo, and of a steep, much shattered one forming the junction of one of its largest western branches with it. Nieve of this form can be divided into two classes: (1) where the projections upon séracs are sculptured by heat into nieve-forms of average size, eighteen inches to over six feet, and (2) where entire séracs from thirty to sixty feet high are thus transformed, constituting a giant form of nieve. The former assumed conical and pyramidal shapes as in case of other varieties. Most of the pinnacles of the latter consisted of huge, slender spires, many having pointed curving apices, and in two instances streamers of ice projected from their points. Although of giant size, the contours of all were evidently shaped by the same laws that govern the development of the smaller varieties, and they exhibited the same prominences, curves, and other features that characterise nieve penitente in general. They were séracs. They were equally nieve penitente. Their final form was merely a question of the sculpturing and moulding by sun and heat of the splintered ice-fragments of the glacier.

It is by no means the case that nieve pinnacles must be of large size, or that the foci from which

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they are developed must be represented by séracs, avalanche-blocks, or large waves in névé several feet distant from one another. The foci may be mere ripples on the surface only two to four inches high, in rows separated from neighbouring ones by only a few inches, and yet the resulting nieve forms may be as perfect as any of larger dimensions.

These latest observations appear to warrant the conclusion that nieve penitente is developed by the action of heat, from whatever source derived, upon névé in which ridges containing centres or foci of hardened snow, and sometimes such centres independent of ridges, have been formed by avalanches, subsidence, or wind, the size and shape of the centres determining the size and shape of the resulting pinnacles; and also upon névé, but more notably upon ice, on which detritus has been deposited under circumstances described, or which has been disrupted into comparatively slender fragments or séracs.

In all cases heat melts away the softer and less protected portions more rapidly than the harder and better protected ones, leaving the latter standing as nieve penitente. The sculpturing process may





## DEFINITION OF NIEVE PENITENTE 199

be assisted in rare instances by the action of water, as in variety VII., which melts, erodes, or compresses the softer parts so as to accentuate the difference in height between them and the harder, and also to a limited extent by evaporation from exposed surfaces; but no evidence of erosion by wind, ice-crystals, or sand was seen by us. During the period when the pinnacles were in process of development in Himalaya, the wind was light or wanting, no loose snow was flying, all snow being fixed by thawing and freezing, and nowhere was any general deposition of sand seen on surrounding surfaces to indicate that sand was moving in the air.

The varieties of nieve penitente observed in the Nun Kun, Hispar, and Skoro regions may be classified according to antecedent cause as follows:—

- |         |  |
|---------|--|
| Variety | I. Avalanche. Three sub-varieties,           |
| „       | II. Subsidence.                              |
| „       | III. Wind-conditioned.                       |
| „       | IV. Thin débris.                             |
| „       | V. Glacier-table.                            |
| „       | VI. Thick débris, mud, sand, gravel-covered. |
| „       | VII. Lacustrine or composite.                |
| „       | VIII. Sérac.                                 |



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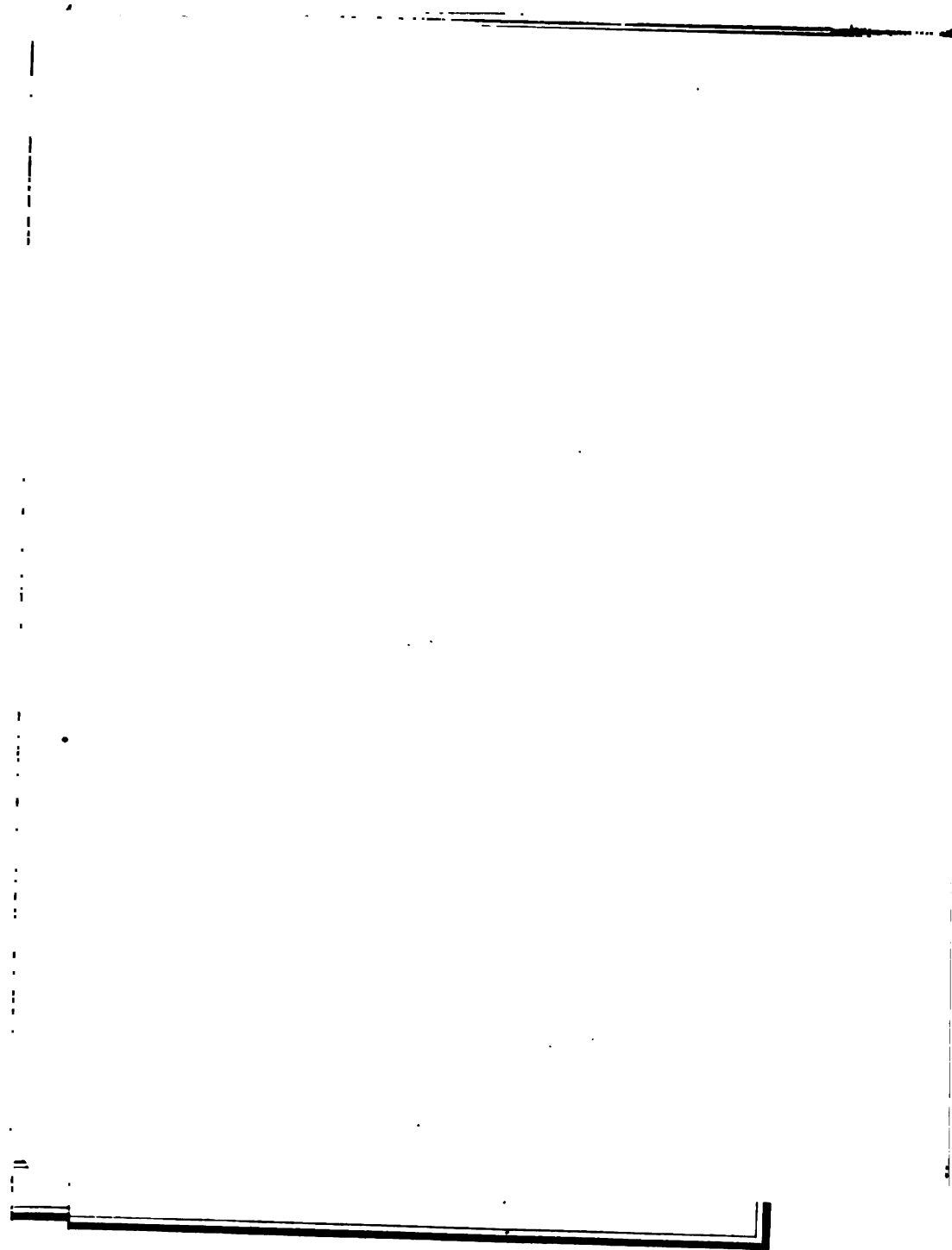
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